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National Petroleum Reserve-Alaska
Integrated Activity Plan
Environmental Impact Statement

Volume 1: Chapter 1-3

U.S. Department of the Interior
Bureau of Land Management

BLM

Alaska

The Bureau of Land Management Today

Our Vision
To enhance the quality of life for all citizens through the balanced
stewardship of America's public lands and resources.

Our Mission
To sustain the health, diversity, and productivity of the public lands
for the use and enjoyment of present and future generations.

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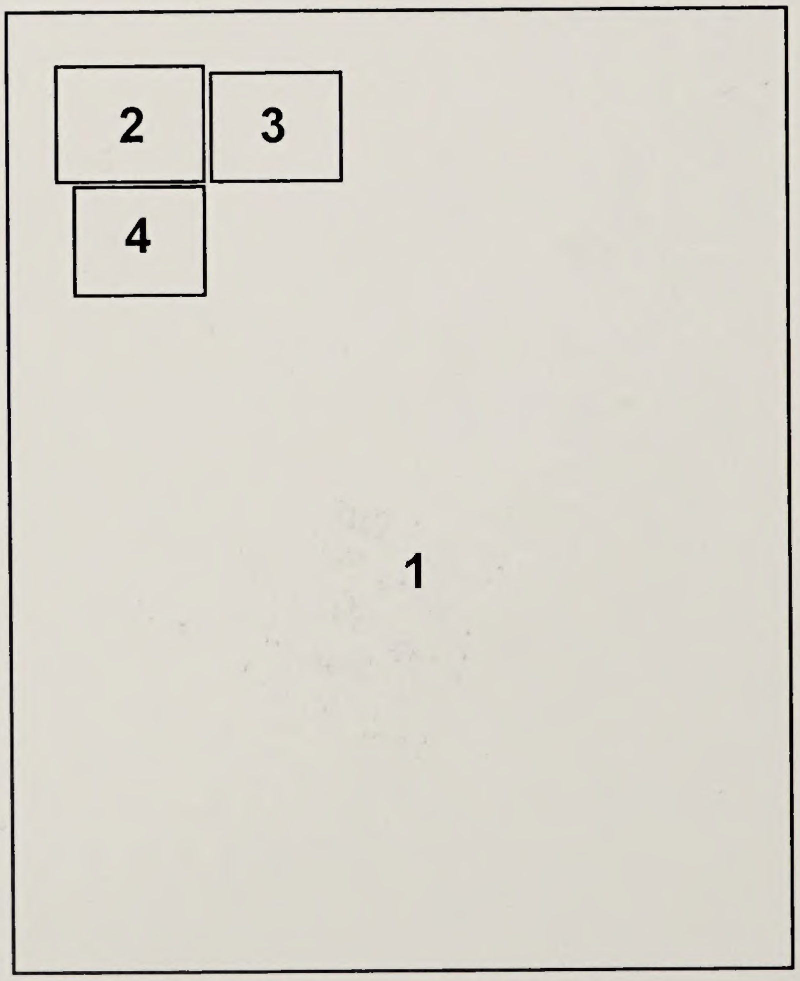

Cover Photos:

1. Along the Archimedes Ridge in the Utukok River Uplands of the National Petroleum Reserve-Alaska.
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2. Winter petroleum exploration, National Petroleum Reserve-Alaska. Photo by NSSI

3. Polar Bear, North Slope, Alaska.

4. Two newly born caribou calves in the Utukok River Uplands of the National Petroleum Reserve-Alaska.
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National Petroleum Reserve-Alaska

FINAL

Integrated Activity Plan/ Environmental Impact Statement

Volume 1

Abstract, Executive Summary, Chapters 1-3

Prepared by:

U.S. Department of the Interior
Bureau of Land Management
Anchorage, Alaska

In cooperation with:

North Slope Borough
U.S. Bureau of Ocean Energy Management
U.S. Fish and Wildlife Service

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November 2012

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
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222 West Seventh Avenue, #13
Anchorage, Alaska 99513-7504
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In Reply Refer To:
1610 (9100)

October 23, 2012

Dear Reader:

We are pleased to present the Bureau of Land Management's National Petroleum Reserve in Alaska (NPR-A) Final Integrated Activity Plan/Environmental Impact Statement (IAP/EIS). This is the first time we have developed a plan describing a range of management options for all federal lands and oil and gas resources within the nearly 23-million-acre NPR-A entrusted to the BLM's care. This document includes the preferred alternative—Alternative B-2—that Interior Secretary Ken Salazar announced on August 13, 2012.

Last March, we released the Draft IAP/EIS. This Final IAP/EIS benefited from the comments we received on that draft plan. We appreciate the thoughtful comments on the draft plan from the cooperating agencies and other agencies, Alaska Native tribes and organizations, environmental organizations, industry, and the public.

This plan offers a balance between development of energy resources, including oil and gas leasing in the NPR-A and onshore facilities to support future offshore oil and gas development, and important protections for the many other resources and uses of these lands in the Petroleum Reserve.

The preferred alternative establishes a broad platform for development over the course of the plan, provides very significant access to known hydrocarbon resources, recognizes the congressional mandate in the transfer act to protect important and special surface values, and was fully informed by the viewpoint of Alaskans who live in the region, State and local governments and other stakeholders.

With release of this Final IAP/EIS, the Environmental Protection Agency (EPA) is publishing a *Federal Register* Notice announcing the plan's availability. The National Environmental Policy Act requires that the BLM wait at least 30 days after the *Federal Register* publishes the EPA's Notice before we issue a Record of Decision to finalize the plan's decisions. The Final IAP/EIS will then guide us in the years ahead as we manage the largest block of land under the BLM's management and some of the richest resources among the federal lands anywhere in the country.

On behalf of the BLM, we look forward to implementing this management plan for all of the NPR-A. If you have questions about this Final IAP/EIS, please call Jim Ducker, Project Lead at (907) 271-3130, or Serena Sweet, Supervisory Planning and Environmental Coordinator (907) 271-4543.

Those who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 1-800-877-8339 to contact the above individuals during normal business hours. The FIRS is available 24 hours a day, seven days a week, to leave a message or question with the individuals noted above. You will receive a reply during normal business hours.

Sincerely,

/S/ Bud C. Cribley

Bud C. Cribley
State Director

National Petroleum Reserve-Alaska Final Integrated Activity Plan/ Environmental Impact Statement

Lead Agency: U.S. Department of the Interior, Bureau of Land Management

Proposed Action: National Petroleum Reserve-Alaska Integrated Activity Plan/ Environmental Impact Statement

Abstract: The Bureau of Land Management (BLM) is proposing a plan for the National Petroleum Reserve in Alaska (NPR-A). The NPR-A Integrated Activity Plan/Environmental Impact Statement (IAP/EIS) is designed to determine the appropriate management of all BLM-managed lands in the NPR-A in light of new information about surface and subsurface resources and in a manner consistent with existing statutory direction. This plan considers five alternatives. Two of the five are presented as subalternatives of Alternative B. The Draft IAP/EIS's Alternative B is presented as Alternative B-1 in this Final IAP/EIS. Alternative B-2 is the preferred alternative. The Draft IAP/EIS did not have subalternative B-2 and did not identify a preferred alternative. The alternatives propose a range of land allocations, including designating new or enlarging existing Special Areas and recommending additions to the National Wild and Scenic Rivers System. They offer a range of options for the amount of lands that would be made available for oil and gas leasing, from 48 percent to 100 percent of the nearly 23 million acres managed by the BLM in the NPR-A. The preferred alternative would make nearly 52 percent of the federally owned subsurface of NPR-A available for oil and gas leasing, while providing protection for surface resources. The alternatives also include stipulations and required operating procedures or best management practices to mitigate impacts to resources and their uses. The IAP/EIS evaluates the potential direct, indirect, and cumulative effects to air quality, paleontological resources, soil and water resources, vegetation, wetlands and floodplains, wildlife, cultural resources, subsistence, sociocultural systems, environmental justice, recreation, visual resources, wilderness characteristics, Wild and Scenic River values, public health, and the economy. Most impacts are related to the potential development of oil and gas.

Further Information: Contact Jim Ducker at (907) 271-3130 or Bridget Psarianos at (907) 271-4208, or via mail at Bureau of Land Management, Alaska State Office, 222 West 7th Avenue, Anchorage, Alaska 99513-7599.

Executive Summary

What is BLM proposing to do in this plan?

The Bureau of Land Management (BLM) completed the National Petroleum Reserve-Alaska (NPR-A) Integrated Activity Plan/Environmental Impact Statement (IAP/EIS) to determine the appropriate management of the BLM-administered lands (public lands) in the nearly 23-million-acre Petroleum Reserve. This plan analyzes management options in the southwestern portion of the Reserve that was not previously covered by a land use plan. In addition, this new IAP updates and supersedes management plans completed in 2004 and 2008 for the Northwest and Northeast NPR-A planning areas and, depending upon which alternative is selected, may amend the Colville River Special Area Management Plan. Among the most important decisions the BLM will make through this plan is what lands should be made available for oil and gas leasing and with what protections for surface resources and uses. (For more information, see Chapter 1).

Why is BLM doing this plan?

The BLM developed the plan for the entire NPR-A to address the nation's need for production of more oil and gas through additional leasing in the NPR-A, and to protect surface values consistent with the exploration and development of oil and gas. This plan addresses the entire NPR-A, and thus provides greater management consistency throughout the Petroleum Reserve than existing separate plans.

This plan will benefit management by incorporating an updated and consistent analysis of issues such as climate change, species recently listed under the Endangered Species Act, updated oil and gas assessments, and ramifications for onshore land management due to offshore oil and gas drilling. Additionally, on May 14, 2011, President Obama directed the Department of the Interior to conduct annual oil and gas lease sales in the NPR-A. Management consistency will better protect sensitive areas while providing development opportunities through these sales.

How is this IAP/EIS different from earlier plans?

This document analyzes a range of management options for the entire NPR-A, including the southwestern portion of the Reserve. Consistent management of the entire NPR-A will provide greater certainty and opportunity to industry while better protecting the environment, public use of the land, and public health.

Several circumstances changed since development of one or both of the previous plans that have also resulted in changes in the analysis. They include:

- **A change in the price of oil**. In this plan, the BLM has based its analysis of economically recoverable oil and gas from the NPR-A on projections for $180 per barrel of oil and $8.67 per thousand cubic feet of gas. (See section 4.2.1.2 in Volume 2.)

- **Updated Information on Economically Recoverable Oil and Gas.** The U.S. Geological Survey's (USGS) 2011 report estimates that 604 million barrels of conventional, undiscovered oil and 17.55 trillion cubic feet of conventional, undiscovered non-associated gas exist within NPR-A and adjacent state waters at prices of $180 per barrel of oil and $8.67 per thousand cubic feet of gas. This estimated volume of oil is based on a 2010 USGS analysis of technically recoverable oil that was less than 10 percent of the 2002 USGS estimate. The new estimate is due primarily to recent exploration drilling indicating an abrupt transition from oil to gas and a reduction in oil reservoir quality 15 to 20 miles west of the Alpine oil field.
- **North Slope Development.** The BLM has analyzed a wider range of development on the North Slope, including unconventional oil and gas exploration and a road to Umiat, and has updated its understanding of other potential development in its cumulative impacts analysis.
- **Chukchi Sea Development.** Chukchi Sea oil and gas resources are considered some of the most promising in the nation. One of the purposes of this plan is to provide an opportunity, subject to appropriate conditions, to construct necessary onshore infrastructure to transport oil and gas resources from offshore leases in the Chukchi Sea to the Trans-Alaska Pipeline System and proposed gas pipelines.
- **Changes to Special Status Species.** The U.S. National Marine Fisheries Service proposed listing the bearded seal and ringed seal as threatened species under the Endangered Species Act in December 2010. The polar bear was listed as threatened throughout its range in May 2008, and critical habitat was designated in November 2010. The U.S. Fish & Wildlife Service concluded that listing the Pacific walrus as a threatened or endangered species is warranted due to loss of sea ice and in 2009 listed the yellow-billed loon as a candidate species and has concluded that listing under the act is warranted. This plan analyzes impacts to seals, walrus, polar bears, and yellow-billed loons in their context as Special Status Species.
- **Additional information.** The IAP/EIS's impact analysis has incorporated relevant new studies related to surface resources, public health, and climate change.

This IAP/EIS also presents potential new mitigation measures to address adverse impacts to several biological resources and to public health, in addition to the protective measures incorporated in the alternatives themselves.

What are the major issues and focus of controversy?

The key issues in the NPR-A IAP/EIS are decisions on the location and amount of oil and gas leasing and protection of surface resources. Of particular interest is the potential impact of development near Teshekpuk Lake, which is considered to have high oil and gas development potential, but is also of great importance for waterfowl, caribou (for calving and relief from insects), and subsistence. The lands near Teshekpuk Lake are currently deferred from leasing until 2018, and all alternatives will honor the leasing deferrals until their expiration. The plan examines a wide range of alternatives for oil and gas development, while offering a range of surface protections. Additionally, this plan considers wilderness characteristics, consistent with BLM policy.

What are the major changes between the Draft and this Final IAP/EIS?

The Final IAP/EIS clarifies and expands upon the analysis in the Draft IAP/EIS in response to new studies and information that have become available since the Draft was printed. The Final IAP/EIS also identifies a preferred alternative, discussed below.

The Final IAP/EIS also incorporates changes based on comments received from the public during the comment period. BLM-Alaska received over 400,000 comments from stakeholders including tribes, Native corporations and other Native organizations, government agencies, elected officials, industry and business organizations, conservation organizations, and individual citizens. The majority of these comments were form letters from interested organizations. The commenters argued for the full spectrum of land use in NPR-A. Some argued that the entire area should be made available for oil and gas leasing; others urged that no oil and gas leasing should take place anywhere in the NPR-A. Also, BLM Field and State Office staff gathered comments at nine public meetings in North Slope villages and other locations.

What alternatives are being considered by BLM?

The IAP/EIS contains five alternatives that provide a broad range of oil and gas leasing availability, surface protections, and Special Area designations. (For more information on the alternatives analyzed, see Chapter 2, particularly section 2.3 and Table 2-3.) Alternative B-2 is BLM's preferred alternative, which was not identified in the Draft IAP/EIS.

Alternative A, the no action alternative, would continue the management established in the current RODs for the Northwest NPR-A IAP, Northeast NPR-A Supplemental IAP, and decisions made as part of the Colville River Special Area Management Plan. There are no current BLM IAP decisions effective for the southern portion of the NPR-A. Under this Alternative, 57 percent of the NPR-A subsurface would be available for oil and gas leasing, while maintaining the four current Special Areas covering 8.3 million acres.

Alternatives B-1 (formerly Alternative B in the Draft IAP/EIS), B-2, C, and D would make between 48 and 100 percent of the total subsurface of the NPR-A, including unleased and currently leased lands, available for oil and gas leasing. These alternatives would make roughly two-thirds to all of the economically recoverable oil production possible, and nearly half to all of the economically recoverable gas production possible from BLM's subsurface estate in the NPR-A. The alternatives would also add zero to 7.2 million acres in designated Special Areas, and recommend zero to 12 rivers within the NPR-A for inclusion in the Wild and Scenic Rivers System.

How does the preferred alternative compare to the alternatives in the Draft IAP/EIS?

The preferred alternative—Alternative B-2—is within the range of alternatives considered in the Draft IAP/EIS. It is most similar to Alternative B-1 (Alternative B in the Draft IAP/EIS), as it makes similar lands unavailable for oil and gas leasing and adds many of the same lands as Alternative B-1 to Special Areas. The preferred alternative offers opportunity to lease oil and gas resources in nearly 52 percent of the NPR-A; Alternative B-1 offers 48 percent of NPR-A lands for lease. The preferred alternative would add approximately 1.9 million acres to the Teshekpuk Lake Special Area (100,000 fewer acres than Alternative B-1) to protect caribou calving and insect-relief areas and waterbird and shorebird breeding, molting, staging, and migration habitats. It creates a new Peard Bay Special Area, though both it and the Kasegaluk Lagoon Special Area would be smaller than in Alternative B-1.

There are two major contrasts between Alternatives B-1 and B-2. The former would recommend designation of 12 rivers for Wild and Scenic River designation, while the preferred alternative would not recommend any river designation. Also, Alternative B-2 does not prohibit the construction of new non-subsistence permanent infrastructure, including pipelines and other infrastructure that would be necessary to transport offshore oil, in most of a large area of lands east of Barrow or in Kasegaluk Lagoon and Peard Bay. This would allow an opportunity for a pipeline to come ashore from the Beaufort Sea, which Alternative B-1 does not, and provides greater flexibility for landfall locations for a pipeline from the Chukchi Sea than in Alternative B-1.

How long will this plan direct BLM management of NPR-A?

The dynamic nature of public land resources and uses requires that BLM maintain, amend, and when necessary, revise its land use plans. This plan will remain in place until it is determined that the underlying analysis, including this Final IAP/EIS, is no longer adequate under NEPA, or until the agency determines that it is appropriate to consider a different approach to management of the Reserve.

What is next?

The BLM will make no decision until at least 30 days have elapsed after this Final IAP/EIS has been issued. The agency would then issue a record of decision stating its decision. Based on that decision, BLM may conduct one or more lease sales in the NPR-A, with the first most likely occurring in 2013.

How the IAP/EIS is Organized

VOLUME 1

Chapter 1 – Introduction: Summarizes the purpose of and need for this IAP/EIS and decisions to be made.

Chapter 2 – Alternatives: Describes and compares proposed management alternatives.

Chapter 3 – Affected Environment: Presents existing natural and socioeconomic resources in the NPR-A and trends, including those associated with climate change.

VOLUME 2

Chapter 4 – Environmental Consequences (sections 4.1 – 4.4): Provides the assumptions upon which the impact analysis rests and evaluates impacts of Alternatives A and B-1 on resources and uses in the NPR-A relevant to making a decision among the alternatives.

VOLUME 3

Chapter 4 – Environmental Consequences continued (sections 4.5 – 4.7): Evaluates impacts of Alternatives B-2 (preferred alternative), C, and D on resources and uses in the NPR-A relevant to making a decision among the alternatives.

VOLUME 4

Chapter 4 – Environmental Consequences continued (sections 4.8 – 4.13): Evaluates the cumulative impacts on resources and uses in the NPR-A and other effects relevant to making a decision among the alternatives.

VOLUME 5

Chapter 5 – Consultation and Coordination: Describes public and government (including tribal) consultation undertaken for this plan and the development of alternatives and lists the plan's preparers.

Chapter 6 – Comments and Responses: Presents public comments on the Draft IAP/EIS and responses to the comments.

VOLUME 6

Appendix A: ANILCA Section 810 Analysis of Subsistence Impacts

Appendix B: Federal, State, and Local Permits and/or Approvals for Oil and Gas Exploration, Development, and Production Activities

Appendix C: NPR-A Climate Change Analysis: An Assessment of Climate Change Variables in the National Petroleum Reserve in Alaska

Appendix D: Essential Fish Habitat

Appendix E: Common, Scientific and Iñupiaq Names of Species Listed in the IAP/EIS

Appendix F: BLM Sensitive Species List for Alaska

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Chapter 1:

Introduction

CHAPTER 1: INTRODUCTION

1.1 Purpose and Need

The Bureau of Land Management (BLM) has completed the National Petroleum Reserve-Alaska (NPR-A or Petroleum Reserve) Integrated Activity Plan/Environmental Impact Statement (IAP/EIS) to determine the appropriate management of all BLM-managed lands in the NPR-A in light of new information about surface and subsurface resources and in a manner consistent with existing statutory direction. Specifically, the Naval Petroleum Reserves Production Act of 1976 (NPRPA), as amended, and its implementing regulations require oil and gas leasing in the NPR-A and the protection of surface values to the extent it is consistent with exploration and development of oil and gas. An additional purpose of the IAP/EIS is to consider consistent oil and gas leasing stipulations and best management practices across the entire Petroleum Reserve, while providing special protections for specific habitats and site-specific resources and uses. Finally, the IAP/EIS is to ensure that the BLM's land management will provide the opportunity, subject to appropriate conditions developed through a National Environmental Policy Act (NEPA) process, to construct pipelines and other necessary onshore infrastructure to bring oil and gas resources from leases in the Chukchi Sea to the Trans-Alaska Pipeline System or a future gas pipeline from the North Slope.

This plan will supersede the current plans—the Northwest NPR-A IAP Record of Decision signed on January 22, 2004, and the Northeast NPR-A Supplement IAP Record of Decision signed on July 16, 2008—and, depending upon which alternative is selected, may amend the 2008 Colville River Special Area Management Plan.

This plan will remain in place until it is determined that the underlying analysis, including this Final IAP/EIS, is no longer adequate under NEPA, or until the agency determines that it is appropriate to consider a different approach to management of the Reserve.

1.2 Cooperating Agencies

The North Slope Borough, the State of Alaska, the U.S. Fish and Wildlife Service (USFWS), and the U.S. Bureau of Ocean Energy Management participate in the IAP/EIS as cooperating agencies. (The State withdrew as a cooperating agency on September 12, 2012.) The BLM requested their participation because of their expertise. Their participation does not constitute their approval of the analysis, conclusions, or alternatives presented in this plan; for these, the BLM is solely responsible.

1.3 Planning Area

The planning area includes all lands and only such lands as are managed by the BLM within the NPR-A. BLM-managed lands total approximately 22.6 million acres of surface and subsurface estate, approximately 429,000 of which are in bays, inlets, and lagoons. Nearly 250,000 additional acres of subsurface estate are under the Alaska Native Claims Settlement Act village corporation surface estate. (See Table 1-1 and Map 1-1; for a more detailed description of land status, see section 3.4.1.) The plan does not make decisions about:

- Surface or subsurface estates owned by Alaska Native Claims Settlement Act regional or village corporations;
- The subsurface oil and natural gas estate of the North Slope Borough near Barrow;
- Lands retained by the U.S. Navy near Point Barrow (Tract #1); or
- The surface lands within (a) certified Native allotments owned by private individuals, (b) the airstrip at Umiat (owned by the State of Alaska), and (c) lands owned by the North Slope Borough near Cape Simpson.

A few considerations regarding the boundary of the NPR-A are as follows. The northern portion of the eastern boundary of the NPR-A is along the western bank of the Colville River. That boundary is defined in Executive Order (EO) 3797-A as the "highest highwater mark...on the [western] bank," which the U.S. District Court for the District of Alaska construed to be "on and along the bank at the highest level attained by the waters of the river when they reach and wash the bank without overflowing it" (*Alaska v. U.S.*; case no. A78-069 Civ. December 7, 1984). Thus, neither the Colville River nor its banks immediately adjacent to the river downstream from approximately longitude 156°08′ are in the NPR-A. The southern part of the eastern boundary of the NPR-A is a line at approximately longitude 156°08′ from the Colville River south to the crest of the Brooks Range. The southern boundary of the NPR-A boundary lies along the top of the Brooks Range to approximately longitude 161°46′, which composes the NPR-A's western boundary from the Brooks Range to the Chukchi Sea. The northern NPR-A boundary encompasses the bays, lagoons, inlets, and tidal waters between the NPR-A's outlying islands and the mainland, thus accounting for over 429,000 acres of submerged estate within the NPR-A. The U.S. Supreme Court (in *U.S. v Alaska*; No. 84, Orig. decided on June 19, 1997) determined that the NPR-A included these tidally influenced waters and that those waters and the submerged lands underlying them did not transfer to the State of Alaska at statehood.

Table 1-1. Lands within the NPR-A managed by the BLM and affected by this plan

Lands affected by this plan	Acres
Federal surface estate and federal subsurface estate	22,522,000
a. Coastal submerged estate	429,000
b. Native-selected	18,000
Federal subsurface estate with non-federal surface estate	247,000
Total acreage	22,769,000

1.4 Scoping and Issues

The BLM conducted formal scoping for the IAP/EIS following publication of a Notice of Intent in the *Federal Register* on July 28, 2010. Scoping meetings were held in Anaktuvuk Pass, Anchorage, Atqasuk, Barrow, Fairbanks, Nuiqsut, Point Lay, and Wainwright in September 2010. Written comments were received through October 1, 2010. For more information on consultation and coordination, including consultation with tribes, both during and after the formal scoping period, see Chapter 5.

Scoping helped the BLM to identify issues. The following are some of the major issues identified during scoping that the IAP/EIS will address.

a. **Oil and Gas:** The vast majority of scoping comments either urged an energetic and liberal oil and gas leasing program or acknowledged that, while advocating important surface resources be protected, oil and gas leasing was a purpose of the NPR-A. The plan will examine a range of alternatives for oil and gas leasing and development, while offering protection for surface resources as required by the NPRPA. The existing 10-year deferrals of oil and gas leasing established in the 2004 Northwest NPR-A Record of Decision and the 2008 Northeast NPR-A Supplemental Record of Decision will be honored in all alternatives until the expiration of the respective deferral periods.

b. **Subsistence**: Subsistence is the primary concern of North Slope residents. Many comments emphasized the importance of protecting subsistence resources, particularly the Teshekpuk Caribou Herd and the Western Arctic Herd and their habitats, and retaining access to subsistence resources for local residents.

c. **Special Area Designation and Management:** Many commenters recommended adding specified new Special Areas and enlarging some of the existing Special Areas. A North Slope resident suggested that local working groups be established to discuss the management of nearby Special Areas. The plan will consider new or enlarged Special Areas and obtaining public input on the management of Special Areas.

d. **Protection of Wilderness Characteristics:** The vast majority of the NPR-A retains characteristics of wilderness and many scoping comments recommended protecting wilderness characteristics. The plan will consider these wilderness characteristics in light of the input of all interested parties and the mandates of the NPRPA.

e. **Wild and Scenic Rivers Designation:** Scoping comments identified many rivers in the NPR-A for consideration for recommendation as a Wild and Scenic River. Consideration of Wild and Scenic River designation is mandated by the Wild and Scenic Rivers Act when "planning for the use and development of water and related land resources" is consistent with the settlement agreement reached between American Rivers and the Department of the Interior in 1993, is consistent with the purpose and need to protect surface resources, and can be done in a manner consistent with oil and gas leasing. Consequently, the plan will consider the suitability of rivers for recommendation for designation as Wild and Scenic Rivers.

f. **Land Rehabilitation:** The NPR-A bears the mark of oil and gas activities that occurred before transfer of management of the land to the BLM. Evidence of past use includes old well sites and piles of drums. The plan will consider means to clean these areas.

g. **Climate Change:** Some scoping comments urged that the BLM take climate change into consideration in the planning alternatives. The plan's performance-based protection measures will allow the BLM's management to be responsive to a changing environment in the NPR-A.

h. **Resource and Use Studies in the NPR-A:** Scoping comments suggested a variety of resource inventory and monitoring undertakings. These included geological and geophysical mapping; air, weather, water, and invasive species monitoring; soils and permafrost surveys; raptor sensitivity studies; and baseline studies of fish, grizzly bears, birds, and special status plants. The IAP/EIS will consider plan decisions for resource inventory and monitoring.

The BLM considered the following issues, but has determined that they are inappropriate for analysis within this IAP/EIS. Those issues for which there was substantial comment during scoping and around which entire alternatives could be constructed, are further discussed in section 2.4.

1. **Hardrock and Coal Mining and Lifting of Other Withdrawals:** The NPRPA withdrew the NPR-A from the operation of the mining laws and other land laws (e.g., Homestead Act, Alaska Statehood Act), extending withdrawals that President Warren Harding put in place when he established the Naval Petroleum Reserve No. 4, the NPR-A's predecessor, in 1923. Substantial numbers of commenters during scoping supported or opposed recommending legislation to open the NPR-A to mining. Such a recommendation or the broader recommendation to lift all withdrawals in the NPR-A advocated by a smaller number of commenters, however, would be contrary to the NPRPA of 1976 and would not be consistent with either of the two major purposes of the NPRPA's establishment of the NPR-A or with two of the primary purposes of this plan (i.e., it would neither further oil and gas leasing nor protect surface values consistent with oil and gas activities).
2. **Incentives for Oil and Gas Development:** Some scoping comments urged the BLM to consider incentives for oil and gas development. Federal law and regulation include incentives to oil and gas leaseholders. Leaseholders can apply for a waiver, suspension, or reduction in rental, royalty, or minimum royalty (regulations are at 43 CFR 3133.3 and 3133.4). Holders of leases may apply for such incentives and the BLM will waive, suspend, or reduce the rental, royalty or minimum royalty based upon specific findings that will be made to specific applications. It is not appropriate to consider such incentives prior to leasing or prior to receiving a specific application from a leaseholder.
3. **Transfer of the NPR-A from BLM Management:** Some commenters suggested that administrative jurisdiction over all or a significant part of the NPR-A should be transferred to the U.S. Fish and Wildlife Service for management as part of the National Wildlife Refuge System. This would require congressional action and is beyond the scope of this planning effort.

4. **Education:** Several commenters suggested that the plan should consider educational initiatives. The suggested initiatives include educating the public regarding certain threats of climate change and helping to train North Slope residents in knowledge of the resources of the NPR-A and its management. The BLM participates in educational programs regarding the NPR-A and its resources both on the North Slope and elsewhere and intends to continue such efforts. These efforts, however, do not respond directly to the purpose and need described in section 1.1. Nor is environmental analysis such as undertaken in this IAP/EIS required for educational initiatives, since educational initiatives are covered by Departmental Categorical Exclusion 1.11 in accordance with 43 CFR 46.210(j).

1.5 Legislative Constraints and Planning Criteria

1.5.1 Legislative Constraints

The BLM undertakes this plan in accordance with its responsibilities to manage the NPR-A under the authority and direction of the Federal Land Policy and Management Act (FLPMA) and the NPRPA. The NPR-A IAP/EIS addresses the BLM's responsibilities under the FLPMA and the NPRPA through a National Environmental Policy Act (NEPA)-required process (i.e., an EIS).

Under the FLPMA, the Secretary has broad authority to regulate the use, occupancy, and development of public lands and to take whatever action is required to prevent unnecessary or undue degradation of the public lands (43 United States Code [USC] § 1732). Each of the alternatives described in Chapter 2, consistent with the mandates of 40 CFR 1502.14, presents a different approach to such regulation of the public lands and presents different approaches to prevent unnecessary and undue degradation.

Under the NPRPA, the Secretary is required to conduct oil and gas leasing and development in the NPR-A (42 USC § 6506a). The Department of the Interior and Related Agencies' Fiscal Year (FY) 1981 Appropriations Act specifically directs the Secretary to undertake "an expeditious program of competitive leasing of oil and gas" in the Petroleum Reserve. The NPRPA provides that the Secretary "shall assume all responsibilities" for "any activities related to the protection of environmental, fish and wildlife, and historical or scenic values" (42 USC § 6503(b)) and authorizes the Secretary to "promulgate such rules and regulations as he deems necessary and appropriate for the protection of such values within the reserve." The NPRPA's implementing regulations are found at 43 CFR Part 2360.

In addition, the NPRPA, as amended, contains special provisions that apply to any exploration or production activities within areas "designated by the Secretary of the Interior containing any significant subsistence, recreational, fish and wildlife, or historical or scenic value" (P.L. 96-514, 42 USC § 6504(a)). Based on this authority, the Secretary in 1977 designated three Special Areas within the NPR-A in which all activities were to "be conducted in a manner which will assure the maximum protection of such surface values to the extent consistent with the requirements of this Act for the exploration of the reserve" (42 *Federal Register* 28,723; June 2, 1977). The Teshekpuk Lake Special Area was created to protect migratory waterfowl and shorebirds. The Colville River Special Area was created to protect the arctic peregrine falcon, which at that time was an endangered species. The

Utukok River Uplands Special Area was created to protect critical habitat for caribou of the Western Arctic Herd. The Secretary of the Interior enlarged the Teshekpuk Lake and Colville River Special Areas in the Northeast NPR-A Record of Decision of 1998. In 2004, the Secretary created the Kasegaluk Lagoon Special Area in the Northwest NPR-A Record of Decision (see Map 3.3.9-1 for the current Special Areas). The current plan recognizes the importance of the resources of the Special Areas and presents different means of providing maximum protection consistent with exploration of the reserve.

The Department of the Interior and Related Agencies' Fiscal Year (FY) 1981 Appropriations Act exempted the Petroleum Reserve from two sections of FLPMA. It exempted the NPR-A from section 202 of FLPMA (43 USC § 1712), which requires the preparation of land use plans (called resource management plans, in regulations—43 CFR Part 1600—adopted by the BLM). Because of the exemption from FLPMA section 202, this plan is not being developed as a resource management plan. While the IAP analyzes a range of possible future BLM management practices for NPR-A in a manner similar to that done in a resource management plan, it is conducted consistent with NEPA regulations—40 CFR Parts 1500-1508—rather than FLPMA regulations. And, consistent with the NPRPA, the NPR-A IAP addresses a narrower range of multiple use management than a resource management plan (e.g., it makes no decisions on opening lands to hard rock or coal mining).

The 1981 Appropriations Act also exempted the NPR-A from section 603 (43 USC § 1782), which required the completion of wilderness reviews and describes the procedures for managing any lands recommended to Congress for wilderness designation, pending Congressional action. Section 1320 of the Alaska National Interest Lands Conservation Act (ANILCA; 43 USC § 1784), however, grants the Secretary discretionary authority to "identify areas in Alaska which he determines are suitable as wilderness" and states that the Secretary "may, from time to time, make recommendations to the Congress for inclusion of any such areas in the National Wilderness Preservation System." While section 603 of FLPMA requires that pending congressional action, the BLM shall manage lands recommended for designation "so as not to impair the suitability of such areas for preservation as wilderness," section 1320 of ANILCA states that "in the absence of congressional action," the BLM shall manage the lands recommended for wilderness designation "in accordance with the applicable land use plans and applicable provisions of law." Consistent with Secretary Ken Salazar's June 1, 2011, memo to the BLM Director, this plan will describe lands in the NPR-A with wilderness characteristics and consider those values in its management decisions.

1.5.2 Planning Criteria

The notice of intent published in the *Federal Register* on July 28, 2010, listed preliminary criteria for the NPR-A IAP/EIS planning effort. Based on public and governmental input on the preliminary criteria and agency review of existing law, NPR-A resources and uses, and agency priorities, the BLM has established the following criteria for all alternatives. Individual alternatives have been derived based on other criteria, such as maximizing the potential for oil and gas development or minimizing impacts on surface resources.

- The plan will consider the lands and waters administered by the BLM within the NPR-A.
- All decisions in the plan will be consistent with the NPRPA, including the requirements to conduct oil and gas leasing and protect surface values to the extent consistent with exploration for oil and gas management within the NPR-A.
- The existing plans defer oil and gas leasing in approximately 1.57 million acres in northwestern NPR-A and 430,000 acres north and east of Teshekpuk Lake. The lands in northwestern NPR-A are deferred from leasing until 2014 and the lands near Teshekpuk Lake until 2018. All alternatives will honor the leasing deferrals for their full terms. Management direction on leasing provided by the alternatives will apply upon expiration of the deferrals.
- Action alternatives will be consistent with requirements for protection of spectacled and Steller's eiders described in the U.S. Fish and Wildlife Service's 2008 biological opinion for the northern NPR-A planning areas and any new biological opinion received as a part of this planning effort.
- The resource protection measures applied to oil and gas authorizations will be as consistent as possible in all areas covered by the plan, recognizing the differing values within the NPR-A.
- The plan will not consider recommendations for legislation to allow hardrock or coal mining or for wilderness designation in the NPR-A.
- The BLM will consider subsistence resources and users and minimize adverse impacts to subsistence uses in accordance with section 810 of the ANILCA.
- The plan will protect valid existing rights.
- The BLM will consider plans and policies of adjacent land owners/managers.

1.6 Planning Process

The IAP/EIS planning process began with the publication in the *Federal Register* on July 28, 2010, of the Notice of Intent to prepare the plan. This began the formal scoping period in which the BLM sought comments on the range of issues to be addressed in the plan. Formal scoping ended October 1, 2010. After the scoping period, the BLM, in consultation with the cooperating agencies and tribes and receiving additional input from the public, researched information on the resources and uses of the area, developed a range of reasonable future management alternatives, and analyzed the impacts of those alternatives. These analyses underwent review within the BLM and among the cooperating agencies, resulting in the Draft IAP/EIS released on March 30, 2012. The comment period was originally to end on June 1, 2012, but in response to public requests, the BLM extended the comment period to June 15, 2012. The public and agencies commented on the Draft IAP/EIS. Based upon these comments and additional analysis, the BLM developed the preferred alternative and revised the Draft to issue this Final IAP/EIS. The BLM will not issue its decision on the plan, called the record of decision, until at least 30 days after publication in the *Federal Register* of the U.S. Environmental Protection Agency's (EPA) notice of the filing of the Final IAP/EIS.

1.6.1 Relationship to BLM Policies, Plans, and Programs

This plan will supersede the current plans—the Northwest NPR-A IAP Record of Decision signed on January 22, 2004, and the Northeast NPR-A Supplement IAP Record of Decision signed on July 16, 2008—and, depending upon which alternative is selected, may amend the Colville River Special Area Management Plan Decision Record signed on July 18, 2008. Completion of this plan is consistent with the agency's program of continuing to offer leasing opportunities in the NPR-A. It is also consistent with the BLM's mandate to protect the surface resources in the NPR-A.

1.6.2 Collaboration

Collaboration with the cooperating agencies has greatly informed this plan. Although the cooperating agencies do not bear responsibility for any of the alternatives or the conclusions of the analysis in this plan, their contributions were felt throughout the planning process and in this plan. Cooperating agencies brought forward ideas for inclusion in alternatives. Some cooperating agencies drafted portions of Chapters 3 and 4 (see the list of preparers in Chapter 5) and cooperating agencies reviewed all of the chapters. The BLM appreciates their efforts.

In addition to working with the local, state, and federal cooperating agencies on this IAP/EIS, the BLM has met with national, state, and local agencies and with tribes to learn of their concerns. The BLM communicated with the National Park Service, which manages lands adjacent to the NPR-A along the crest of the Brooks Range, to ensure that their concerns were fully understood. The BLM has consulted with the BLM-Alaska Resource Advisory Council, which is a 15-member panel representing local governments, Alaska Natives, and leaders from the conservation, energy, mining, recreation, and tourism communities, at resource advisory council meetings that have occurred since July 2010. In August 2010, the BLM initiated tribal consultation with letters to 43 villages (see Chapter 5 for a complete list). The BLM met with representatives from North Slope tribes and the North Slope Borough on the NPR-A's Subsistence Advisory Panel to discuss the plan six times prior to issuing this Final IAP/EIS.

The BLM has engaged with state or federal agencies to satisfy the requirements of several acts, including section 106 of the National Historic Preservation Act and the Endangered Species Act (ESA). The BLM is consulting with the Alaska State Historic Preservation Office (SHPO) as part of section 106 consultation under the National Historic Preservation Act to determine how proposed activities could impact cultural resources listed on or eligible for inclusion in the National Register of Historic Places. The BLM initiated this consultation with the SHPO for the IAP/EIS with a letter of January 19, 2011. Consultation with the SHPO is ongoing and will be completed by the time of the signing of the record of decision.

The BLM is also consulting with the USFWS and National Oceanic and Atmospheric Administration (NOAA) Fisheries Service as required under section 7 of the ESA during the IAP/EIS process. The BLM initiated consultation with both agencies on April 11, 2012 by sending memoranda requesting a list of species and critical habitat that might be affected by the plan. Based upon these agencies responses and through further consultation with them, BLM prepared biological assessments that were submitted to the agencies on

September 26, 2012 and October 1, 2012, respectively. These consultations are ongoing and will be completed by the signing of the record of decision.

The BLM has consulted with the U.S. Forest Service, the U.S. Fish and Wildlife Service, the National Park Service, and the U.S. Environmental Protection Agency (EPA) regarding the analysis and mitigation of potential impacts to air quality and air quality related values associated with oil and gas development on federal lands within the planning area. The consultations, pursuant to a June 2011 memorandum of understanding among the U.S. Department of Agriculture, the U.S. Department of the Interior, and the EPA, include the Division of Air Quality in the Alaska Department of Environmental Conservation.

1.7 Requirements for Further Analysis

NEPA documentation is required before the BLM can authorize actions that impact the environment. Actions that could individually or cumulatively have a significant effect on the environment would be authorized only after completion of an EIS. Actions that are not anticipated to have a significant effect on the environment could be authorized after completion of an environmental assessment (EA). Actions that have been shown not to have the potential for individual or cumulative significant impacts can be authorized using categorical exclusions.

The decision regarding oil and gas leasing resulting from this plan may authorize multiple lease sales. The first lease sale based upon this plan and associated record of decision most likely would occur in 2013, with subsequent annual lease sales. For impact analysis purposes, this plan assumes that all lands that the record of decision determines to be available for leasing would be offered in the first and subsequent lease sales, though lands with the current 10-year deferrals would not be offered until after the expiration of those deferrals. Readers should bear in mind, however, that the first sale, as well as any subsequent sale, might offer only a portion of the lands identified in the record of decision as available, making possible a phased approach to leasing and development. The area offered in the first sale would be within the area identified in this plan's record of decision as available and not deferred for leasing. The timing of and the lands offered for lease in the second and subsequent sales, if any, would depend in part on the response to the first sale and the results of the exploration that follows.

The BLM anticipates that this IAP/EIS will fulfill the NEPA requirements for the first oil and gas lease sale and for any potential renegotiations of the stipulations of previously leased tracts in the planning area. Prior to conducting each additional sale, the agency would conduct a determination of the existing NEPA documentation's adequacy. If the BLM finds its existing analysis to be adequate for a second or subsequent sale, the NEPA analysis for such sales may require only an administrative determination of NEPA adequacy.

Future actions requiring BLM approval, including a proposed exploratory drilling plan, proposed construction of infrastructure for development of a petroleum discovery, or development of a Wild and Scenic River management plan for any river designated as a Wild and Scenic River by Congress, would require further NEPA analysis based on specific and detailed information about where and what kind of activity is proposed. Additional site-specific terms and conditions may be required by the authorized officer under the authority of 43 CFR 3131.3 prior to authorizing any oil and gas activity.

1.8 Consistency with Federal, State, and Local Laws and Regulations

The BLM and any leaseholder or applicant for a BLM permit or other authorization must comply with multiple federal laws that govern activities on public lands. The Clean Air Act governs air pollutant emissions, and requires the EPA and states to carry out programs to ensure attainment of the National Ambient Air Quality Standards. The Clean Water Act regulates discharges into waters of the United States, including wetlands. The Resource Conservation and Recovery Act regulates the treatment, storage, and disposal of solid and hazardous wastes, while the Comprehensive Environmental Response, Compensation, and Liability Act regulates how to clean up releases of hazardous substances and the notification of agencies in case of a release.

Several laws pertain to the protection of plants and animals and their habitats. The Endangered Species Act (ESA) provides for conserving endangered and threatened species of plants and animals. The ESA also requires that federal agencies consult with the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service to ensure that any actions that they authorize, fund, or carry out are not likely to jeopardize the continued survival of a listed species or result in the adverse modification or destruction of its critical habitat. The Magnuson-Stevens Fishery Management and Conservation Act requires consultation with the NOAA Fisheries Service on essential fish habitat.

The Fish and Wildlife Conservation Act of 1980 encourages federal agencies to conserve and promote the conservation of nongame fish and wildlife species and their habitats. The Migratory Bird Treaty Act makes it unlawful to directly or indirectly harm migratory birds. The Sikes Act authorizes the U.S. Department of Interior to plan, develop, maintain, and coordinate programs with state agencies for the conservation and rehabilitation of wildlife, fish, and game on public lands.

The Wild and Scenic Rivers Act of 1968 requires that in all land and water use planning for development, consideration "shall be given by all federal agencies involved to potential wild, scenic, and recreational river areas" (16 USC § 1276(d)). The Act was created to help preserve rivers from being dammed, channelized, and over-developed and requires that the BLM address Wild and Scenic River values in its planning efforts. The Act establishes a National Wild and Scenic Rivers System and prescribes the methods and standards through which additional rivers may be identified and added to the system.

The Rivers and Harbors Act of 1899 prohibits the construction of any bridge, dam, dike, or causeway over or in navigable waterways of the U.S. without U.S. Army Corps of Engineers approval. Under section 10 of the Act, the building of any wharves, piers, jetties, or other structures is prohibited without Army Corps of Engineers approval, and excavation or fill within navigable waters requires the approval of the Chief of Engineers, Army Corps of Engineers.

Laws and acts that pertain to the protection of historic and cultural resources and the rights of Alaska Native groups include the Historic Sites Act of 1935, which provides for the preservation of historic American sites, buildings, objects, and antiquities of national significance. The National Historic Preservation Act requires Federal agencies to take into account the potential effects of their actions on properties that are listed or are eligible for listing on the National Register of Historic Places, and to consult with State Historic Preservation Offices and local governments regarding the effects of federal actions on historic properties. The Archeological Resources Protection Act prohibits the excavation, removal, damage, or other alteration or defacement of archaeological resources on federal or Indian lands without a permit.

The American Indian Religious Freedom Act of 1978 requires federal land managers to include consultation with traditional Native American or Alaska Native religious leaders in their management plans. The Native American Graves Protection and Repatriation Act of 1990 recognizes the property rights of Alaska Natives to certain cultural items, including Alaska Native human remains and sacred objects.

Section 810 of ANILCA addresses issues related to the effects of proposed activities on subsistence use. An ANILCA section 810 notice and public hearing process is required if a proposed action would significantly restrict subsistence uses. An evaluation and proposed finding of effects on subsistence uses and needs from actions that could be undertaken under this plan, provided in Appendix A, was based on information contained in this Final IAP/EIS.

The FLPMA of 1976 directs the BLM to “take any action necessary to prevent unnecessary or undue degradation of public lands.” The NPRPA of 1976 delegates authority to the Secretary of the Interior for surface management of the National Petroleum Reserve-Alaska and protection of surface values from environmental degradation, and authorizes the preparation of rules and regulations necessary to carry out its surface management and protection duties. The BLM, within the Department of the Interior, has been delegated management authority for the Petroleum Reserve.

This IAP/EIS follows, as will subsequent permitting actions, the guidelines in several Executive orders, including, but not limited to:

- Executive Order 11988, Floodplain Management, which was issued in order to avoid, to the extent possible, the long- and short-term impacts associated with the occupancy and modification of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative.
- Executive Order 11990, Protection of Wetlands, which directs federal agencies to “minimize the destruction, loss, or degradation of wetlands, and enhance and preserve the natural and beneficial values of wetlands” when carrying out actions on federal lands.
- Executive Order 12898, Environmental Justice, requires that federal agencies address the disproportionate effects of their actions on minority populations and on low-income populations.

The State and the North Slope Borough require permits for certain activities within the planning area. These are discussed in section 1.9. The North Slope Borough believes that it has concurrent jurisdiction within the NPR-A derived from the jurisdiction transferred to the State under the Alaska Statehood Act and the Borough's status as a home rule municipality. It is the BLM's policy to consider the North Slope Borough's land management regulations to the extent practical in any decision within the NPR-A. Although the BLM acknowledges the Borough's local land use plan, it is the BLM's position that the Borough's plans cannot prohibit activities on federal lands. All activities on federal lands must be authorized by the BLM.

1.9 Federal, State, and North Slope Borough Permits and Approvals Needed to Undertake On-the-ground Activities

The following discussion focuses on some of the permits that would be required by various agencies prior to approval of on-the-ground activities, including those for oil and gas exploration or development. This is only a partial listing; a more inclusive list is provided in Appendix B.

The Army Corps of Engineers administers two permits relevant to proposed oil and gas activities in the NPR-A. The first permit is issued by the Corps pursuant to section 404 of the Clean Water Act, which addresses the discharge of dredged or fill material into waters of the U.S., including wetlands. In addition, the Alaska Department of Environmental Conservation must certify that the 404 permit meets State water quality standards. To meet section 404 requirements, any future NEPA document would describe the project's components, identify the type and amount of wetlands and other waters affected by each alternative, describe anticipated impacts, and discuss mitigation measures that could minimize impacts to these resources.

Section 10 of the Rivers and Harbors Act of 1899 is the source for the second Army Corps of Engineers-administered permit. To address the requirements of this section as they pertain to construction of structures or work in or affecting navigable waters of the U.S., any future NEPA document must describe the navigable waters of the U.S within the project area and how structures in, on, or over these waters would affect them during construction and operation. The NEPA document would describe the alternatives and compare possible impacts to coastal integrity and navigation for each alternative. It would also discuss mitigating measures to minimize these impacts. In addition, section 10 of the Rivers and Harbors Act requires that an applicant desiring to build a bridge across a navigable stream obtain a permit from the U.S. Coast Guard. The Coast Guard is responsible to ensure that such a bridge does not obstruct or alter a navigable stream.

The EPA and authorized states issue National Pollution Discharge Elimination System permits required by the Clean Water Act; EPA transferred authority to administer this program to the State of Alaska in October 2012. To provide information for these permits, any future NEPA document would describe existing water quality and the quantity of water requirements for the proposed project, expected pollutants and their concentrations, and the quality and locations of wastewater treatment facilities and discharges. The EPA administers, and the Alaska Department of Environmental Conservation issues, other

Clean Water Act mandated permits for wastewater authorization, oil discharge prevention and contingency plans, storm water discharge, and underground injection authorizations.

The State has responsibility for issuance of several permits. Alaska's Department of Natural Resources issues temporary water use and water rights permits, cultural resources concurrences, and other authorizations for activities associated with oil and gas development. The Alaska Department of Fish and Game issues fish habitat permits. Under their state implementation plan, the Alaska Department of Environmental Conservation issues prevention of significant deterioration and other air quality permits. The Alaska Department of Environmental Conservation also is responsible for issuing several permits and plan approvals for oil and gas exploration and development activities, including the storage and transport of oil and cleanup of oil spills. The Alaska Oil and Gas Conservation Commission is responsible for issuing drilling permits and for production, injection, and disposal plan approvals for exploration and development activities in the State of Alaska.

Finally, the North Slope Borough, as a Home Rule Borough, issues development permits and other authorizations for oil and gas activities under the terms of its ordinances.

1.10 Interrelationships and Coordination with Other Agencies and Government-Sponsored Groups

The BLM coordinates with state and local agencies to satisfy the requirements of several acts, including the Sikes Act, FLPMA, and section 106 of the National Historic Preservation Act. The BLM coordinates closely with state resource management agencies on issues involving the management of public lands and protection of fish and wildlife populations, including federal and state-listed threatened and endangered species. The BLM coordinates at the national and local level with several resource advisory groups, including the BLM-Alaska Resource Advisory Council.

To ensure local participation in the decision-making process as it relates to subsistence use in the NPR-A, the BLM established a local subsistence advisory panel. The individual tribal governments of Anaktuvuk Pass, Atqasuk, Barrow, Nuiqsut, Point Lay, and Wainwright; as well as the Iñupiat Community of the Arctic Slope, a regional tribal entity; and the North Slope Borough are all represented on the panel. The advisory panel's purview encompasses all of the NPR-A. The responsibilities of this panel are and will continue to include:

- Providing recommendations to the BLM concerning planning, research, monitoring, and assessment activities needed to facilitate responsible development and to protect subsistence resources and uses in the NPR-A;
- Identifying potential conflicts between subsistence use and other resource uses;
- Informing local communities about agency actions affecting subsistence resources and uses in the NPR-A;
- Informing agencies of panel activities;
- Working with the North Slope Borough to maintain a repository of subsistence information concerning the NPR-A for use by local communities and agencies; and
- Helping the BLM ensure continuity and consistency in the collection and use of subsistence information by the advisory panel and other groups.

The panel is responsible for reviewing resource-related development plans within the NPR-A and issuing recommendations to the BLM regarding whether the plans adequately consider subsistence. The BLM will work with the panel and any permittees to resolve conflicts between subsistence use and resource development. The BLM will work closely with the panel to develop a plan to monitor the effects of development on subsistence resources and users. Should monitoring identify the existence of impacts on subsistence uses, the panel would make recommendations to the BLM regarding: (1) additional mitigating measures, (2) potential relocation of operations or redesign of facilities, and (3) more effective mechanisms for enforcement of subsistence protective measures.

Chapter 2:

Alternatives

CHAPTER 2: ALTERNATIVES

2.1 Introduction

This chapter presents five alternative approaches to achieving the purpose and need of the NPR-A IAP/EIS described in section 1.1. Alternative A is the no-action alternative and reflects current management of the NPR-A established in the 2004 and 2008 records of decision for the Northwest and Northeast NPR-A, respectively, and the Colville River Special Area Management Plan of 2008.

Alternative B-1, the Draft IAP/EIS's Alternative B, offers opportunities for oil and gas leasing on nearly half of the Reserve while protecting surface resources of NPR-A with substantial increases in areas designated as Special Areas, designation of extensive areas that would be unavailable for leasing around Teshekpuk Lake and in the southwestern part of the Reserve with important caribou habitat and important primitive recreation values, and recommendation for designation of 12 Wild and Scenic Rivers.

Alternative B-2 is a new alternative and is the BLM's preferred alternative; the Draft IAP/EIS did not identify a preferred alternative. The preferred alternative offers opportunity to lease oil and gas resources in nearly 52 percent of the NPR-A. It adds many of the same lands as Alternative B-1 to Special Areas and makes similar lands unavailable for oil and gas leasing. Unlike Alternative B-1, the preferred alternative does not prohibit the construction of new nonsubsistence permanent infrastructure, including pipelines and other infrastructure that would be necessary to transport offshore oil, in most of the lands east of Barrow or in the Kasegaluk Lagoon and Peard Bay Special Areas, which would be unavailable for oil and gas leasing. It also differs from Alternative B-1 in that it would not recommend any Wild and Scenic River designations.

Alternative C offers opportunity to lease oil and gas resources in more than three-quarters of the Reserve while providing smaller additions to Special Areas than Alternatives B-1 and B-2, makes unavailable for leasing the most remote part of NPR-A that has the greatest potential for providing a primitive recreation experience, provides for leasing with extensive surface protection stipulations near Teshekpuk Lake, and recommends three rivers for designation as Wild and Scenic Rivers.

Alternative D would allow the BLM to offer all of the NPR-A for oil and gas leasing, while protecting surface values with a collection of protection measures.

This chapter also describes alternatives considered but eliminated from detailed analysis and the reasons why these alternatives were eliminated from further consideration. Finally, Table 2-4 summarizes the impacts of the alternatives considered in detail in this IAP/EIS.

2.1.1 Formulation of the Alternatives and Mitigation Measures

The alternatives presented in this IAP/EIS address concerns of the public including those presented through the formal scoping period that occurred from July 28, 2010 to October 1, 2010 and the comment period on the Draft IAP/EIS from March 30 to June 15, 2012, and those raised through consultation with tribes and cooperating agencies. The range of alternatives presented in this chapter also responds to the land management concerns raised by BLM managers and staff.

The alternatives have benefitted from the insights and expertise of the cooperating agencies, though the cooperating agencies are not responsible for the range of alternatives examined in this IAP/EIS. The North Slope Borough, the State of Alaska, the U.S. Fish and Wildlife Service (USFWS), and the U.S. Bureau of Ocean Energy Management participated in the planning process as cooperating agencies in order to maximize use of available resources and special expertise and minimize duplication in those areas of overlapping responsibilities. (The State of Alaska withdrew as a cooperating agency on September 12, 2012.) Cooperating agency status does not, however, indicate these agencies' implicit or explicit support for any particular alternative. The BLM as the lead agency is solely responsible for the alternatives in this IAP/EIS.

The alternatives are described in sections 2.2 and 2.3. Table 2-1 on page 28 summarizes major land allocations of the alternatives and many of their most important protections are described in Table 2-2 on page 29 and Table 2-3 on page 42. Some of the alternatives designate or recommend the designation of Special Areas or Wild and Scenic Rivers and each of the alternatives contain measures to mitigate or avoid unnecessary surface damage and minimize ecological disturbance throughout the planning area. As described in section 2.1.2, each alternative presents a different approach to providing maximum protection to surface resources within the four designated Special Areas in the NPR-A—the Teshekpuk Lake Special Area, the Colville River Special Area, the Utukok River Uplands Special Area, and the Kasegaluk Lagoon Special Area—and three of the alternatives present approaches to protect values of a proposed new Peard Bay Special Area. Finally, the alternatives provide other direction for management of a variety of resources and uses of the NPR-A.

The BLM is analyzing this range of alternatives to ensure that a wide range of management options are considered, consistent with the law, and address public scoping suggestions and agency concerns for protection of resources. Any decision that the BLM makes following the analysis done through this IAP/EIS must be consistent with the Naval Petroleum Reserves Production Act (NPRPA) and with other applicable laws and regulations.

"Mitigation measures," as the term is used in the BLM's NEPA Handbook (page V-20), are introduced in the environmental consequences analysis in Chapter 4. Such mitigation measures are not part of the alternatives, unlike lease stipulations, required operating procedures, and best management practices (for a discussion of stipulations, required operating procedures, and best management practices, see section 2.3.5). Rather they are suggestions of additional means to lessen impacts that are identified in the impact analysis in Chapter 4. Some of these mitigation measures may not be within BLM's authority to implement, and thus would require the involvement of other agencies. These mitigation measures, along with a description of their effectiveness to mitigate impacts as well as any impacts these measures would themselves create, are included to allow for public consideration and comment. Some mitigation measures described and analyzed in Chapter 4 of the Draft IAP/EIS have been incorporated into the preferred alternative. The record of decision will identify which mitigation measures identified in Chapter 4 the BLM would adopt.

2.1.2 Special Areas and Other Areas with Additional Protections

The NPR-A currently includes four designated Special Areas (see section 3.3.9). The Teshekpuk Lake Special Area was designated primarily to protect important nesting, staging, and molting habitat for a large number of waterfowl. The area also provides important habitat for caribou and serves as an important area for subsistence resources and uses. The Colville River Special Area lies along that river and two of its larger tributaries, the Kogosukruk and Kikiakrorak rivers. The area was designated to protect the arctic peregrine falcon, which inhabits bluffs within the Special Area and was listed as an endangered species at the time the Colville River Special Area was designated; the species was delisted in 1994. The Utukok River Uplands Special Area encompasses nearly 400,000 acres in the southwestern portion of the NPR-A. It was designated in 1977 because of its critical importance for the Western Arctic Herd of caribou, which was then in decline, but today is the largest herd on the North Slope. The BLM created the Kasegaluk Lagoon Special Area pursuant to the record of decision for the Northwest NPR-A IAP. The 2004 record of decision explained that it was being created “primarily because of high values for marine mammals.” Alternatives B-1, B-2, and C would enlarge existing Special Areas and designate a new Peard Bay Special Area. Special Area designation does not itself impose specific protections, but instead highlights areas and resources for which the BLM will extend “maximum protection” consistent with exploration of the Reserve.

Each alternative also identifies other areas with exceptionally important surface resources, many of which overlap the existing or proposed new or expanded Special Areas. Alternatives B-1 and C would recommend nomination of rivers for congressional designation as additions to the Nation’s system of Wild and Scenic Rivers. Other areas identified in the “K” series of stipulations and on the alternative maps, such as the Teshekpuk Lake Caribou Habitat Area and the Teshekpuk Lake Goose Molting Area, are not in themselves administrative or legislative designations, and they carry with them no formal regulatory special status. They are simply areas that the BLM has identified through the planning process where resource concerns are provided special protections.

2.2 Management Actions Common to All Alternatives

Before considering the various management strategies put forward in these alternatives to meet the purpose and need described in Chapter 1, readers should be aware that some management actions will occur under all alternatives. These actions include fulfilling the BLM’s responsibility to convey land to individual Alaskan Natives and to Native corporations under the Native Allotment Act and the Alaska Native Claims Settlement Act, respectively, and administration of current oil and gas leases and unit agreements.

In cooperation with other federal, State, and North Slope Borough resource management agencies, the BLM also will conduct studies, such as the inventory and monitoring of resource populations and conditions, under all alternatives. These studies will assess the health of biological resources, the location and significance of other resources, and the effectiveness of management practices in protecting these resources. The scope of these studies will reflect the level of impacting actions allowed and the protective measures imposed under the plan adopted through this IAP/EIS. See the discussion in section 2.5 for examples of ongoing monitoring and inventory projects.

The BLM, working in concert with appropriate state agencies (AOGCC and ADEC), will continue to update the Strategic Plan for Legacy Wells (inactive wells drilled prior to transfer of NPR-A to BLM). The update will incorporate the latest site inspection information and develop a process to conduct a risk evaluation of those sites, a prioritized list of wells that require remediation or plugging efforts, and a budget proposal for funding remediation or plugging. Public health and safety and resource protection are the priority drivers for the risk ranking. None of the management prescriptions in any of the alternatives would prevent the implementation of a plugging and remediation program. Implementation of the strategic plan will be subject to available funding.

The BLM will continue to work closely with responsible parties to encourage cleanup of contaminated and solid waste sites in the NPR-A. These include, but are not limited to, formerly used defense sites, Air Force installations authorized under rights of way, staging areas, and other sites.

The BLM will determine how the NPR-A will be managed, including how the purposes of any Special Areas will be achieved. In implementing this management, the BLM may consult with local residents. It may also confer with and/or otherwise invoke the resources and expertise of other federal, State, and local agencies and of tribes to assist in achieving these objectives. This may include cooperative agreements with other federal, State, or local agencies or with tribes ranging from agreements for technical assistance to an agreement whereby another federal, State, or local agency or tribe would agree to assist in management of some resources and/or lands. The implementation of any cooperative management agreement would continue to be subject to, and consistent with, the BLM's underlying statutory and regulatory requirements for the management of NPR-A, including its Special Areas, as well as the suite of stipulations, required operating procedures, and best management practices that apply to the record of decision for this plan.

The BLM and/or those using the NPR-A are also subject to many other laws and regulations that provide protection for resources, such as the National Historic Preservation Act and the Endangered Species Act. These requirements will be met under all alternatives. For a detailed list of laws and regulations that would be effective in all of the alternatives, see the discussions in sections 1.8 and 1.9 and Appendix B. In addition, regardless of the decision resulting from this planning effort, the BLM in subsequent permitting decisions will provide "maximum protection" for the surface values for which Special Areas are designated consistent with the purposes of the NPRPA.

2.3 Description of the Alternatives

Subsections 2.3.1 through 2.3.4 describe the five alternatives—Alternatives A, B-1, B-2, C, and D. Alternative B-2 is the preferred alternative. The Draft IAP/EIS presented Alternatives A, B, C, and D. Alternative B-1 of this Final IAP/EIS is described and analyzed in the Draft IAP/EIS as Alternative B. The Draft IAP/EIS did not identify a preferred alternative. After receiving public comment on the Draft IAP/EIS and further consultation with cooperating agencies and other stakeholders, the BLM developed Alternative B-2 as the preferred alternative. As described further below, the preferred alternative is a combination of elements analyzed within the alternatives described in the Draft IAP/EIS and is within the spectrum of those alternatives. Therefore, no supplemental environmental impact statement is required. Additional discussion of the alternatives and the protections associated with them can be found in Table 2-2 and Table 2-3.

All the alternatives identify lands that could be offered for oil and gas leasing in lease sales following the record of decision for this plan. It should be understood, however, that BLM has discretion to offer for lease in any given lease sale all or only some of the unleased lands that, based on the existing IAP decision document, are available for leasing. The plan also identifies lands on which oil and gas leasing would not be allowed or would be deferred. Alternatives A, B-1, B-2, and C identify some lands that would be unavailable for leasing. Alternative A also includes time-limited deferrals. Those deferrals to 2014 and 2018 also will be honored in the other alternatives; in the case of Alternatives B-1 and B-2, the deferral to 2018 is essentially superceded by making the deferred lands unavailable.

The BLM will determine how the surface protection measures included in the alternatives will be achieved. In implementing these surface protection measures, the BLM may confer with and/or otherwise invoke the resources and expertise of other federal, State, and local agencies and tribes to assist in achieving these objectives.

Note: Throughout this IAP/EIS, when exceptions are allowed for the development of "valid existing NPR-A oil and gas leases," the term "valid existing NPR-A oil and gas leases" refers to oil and gas leases issued by the BLM prior to the signing of a record of decision for this plan and valid at the time of the application for approval of an action for which the "valid existing NPR-A oil and gas lease" exception is requested.

Also note, all setback distances in the alternatives are to be measured as of the time of the application for a permit for a development. In addition, for Alternatives B-1, B-2, C, and D, facility development along the coast would be required to be designed to maintain the prescribed setback distance for the anticipated life of the facility.

2.3.1 Alternative A – No-action Alternative

Alternative A is the no-action alternative and is comprised of decisions established in the current records of decision for the Northwest NPR-A IAP (January 22, 2004) and the Northeast NPR-A Supplemental IAP (July 16, 2008) as well as decisions reached as part of the Colville River Special Area Management Plan (July 18, 2008). The decisions described in this alternative constitute a continuation of the BLM's existing management practices in the NPR-A. Except for certain provisions of the Colville River Special Area Management Plan, no current BLM planning decisions are effective for the portions of the NPR-A outside of the Northeast and Northwest NPR-A planning areas.

Under this alternative, approximately 57 percent (13 million acres) of the NPR-A's approximately 22.8 million subsurface acres could be offered in future oil and gas lease sales (Map 2-1), though approximately 2 million acres of the available lands would remain deferred from leasing until 2014 or 2018. The lands deferred from leasing would include approximately 1.57 million acres in the far northwestern part of the NPR-A and approximately 425,000 acres north and east of Teshekpuk Lake. The deferred lands in the northwestern NPR-A and near Teshekpuk Lake would be available for leasing after the expiration of the deferrals on January 22, 2014, and July 16, 2018, respectively. While this plan makes no decision regarding a corridor for infrastructure associated with offshore development, such a corridor could be accommodated in this alternative, subject to appropriate conditions developed through a NEPA process.

Teshekpuk Lake and its islands would remain unavailable for leasing. More than 9 million acres in the southern part of the NPR-A have not been the subject of an IAP. Those lands were analyzed in a 1983 EIS for oil and gas leasing throughout the NPR-A. The BLM, however, considers the 1983 EIS inadequate for renewed leasing. Consequently, no oil and gas leasing would occur for these lands in the southern NPR-A under Alternative A.

Lands with particularly high surface resource values, especially those within Special Areas, would continue to receive special protection through stipulations and required operating procedures. For example, caribou calving and insect-relief habitat would receive special protection through development restrictions and timing and spatial constraints on activities, and there would be setbacks for permanent oil and gas infrastructure and certain activities from lakes important for their waterfowl (including molting geese) and fish habitat, from rivers for their riparian values for many resources and subsistence use, and from the coast (including on barrier islands) to protect marine mammal and caribou insect-relief habitat. These setbacks, and those in the other alternatives, vary to reflect different sensitivities to use by different resources and, in some cases, because of the level of subsistence use. All distances from lakeshores, rivers, and the coastline for this and all alternatives would be measured at the time of application for an activity, subject to adjustment for any substantial change prior to construction. For a fuller description of these and other protections that would be ensured through leasing stipulations or permit requirements, see Table 2-3, particularly the “K” stipulations, which are depicted on Map 2-1K. Table 2-2 identifies additional measures associated with this alternative.

2.3.2 Alternatives B-1 and B-2

The BLM has developed a preferred alternative that has benefited from the comments on the Draft from the public and government agencies. The preferred alternative is presented in this Final IAP/EIS as Alternative B-2 because of its similarities to the version of Alternative B presented in the Draft IAP/EIS. Alternative B-1 is the version of Alternative B that was presented in the Draft IAP/EIS.

2.3.2.1 Alternative B-1

Alternative B-1 emphasizes the protection of surface resources, while making nearly 11 million acres of federally owned subsurface (48 percent of the total in the NPR-A) available for oil and gas leasing (Map 2-2-1). Of the lands currently deferred from leasing, some would be made available for leasing after expiration of the deferrals described in Alternative A (Map 2-1). Others of these currently deferred lands would not become available because, under this alternative, they would be unavailable for leasing. While this plan makes no decisions regarding a corridor for infrastructure associated with offshore development in the Chukchi Sea, such a corridor could be accommodated in this alternative, subject to appropriate conditions developed through a NEPA process. This infrastructure would not be allowed, however, on lands where new non-subsistence permanent infrastructure is prohibited.

Alternative B-1 would enlarge three Special Areas and create one new Special Area. It would add approximately 2 million acres to the Teshekpuk Lake Special Area to protect caribou calving and insect-relief areas and waterbird and shorebird breeding, molting, staging, and migration habitats. The purpose of the Teshekpuk Lake Special Area would be expanded to include the protection of important caribou and shorebird habitat while continuing to protect waterbird habitat, which was the original purpose for the Special Area. The alternative would expand the Kasegaluk Lagoon Special Area southward to encompass an additional 267,000 acres to offer protection to waterbird and shorebird breeding, molting, staging, and migration habitats. Alternative B-1 would add approximately 3.1 million acres to the Utukok River Uplands Special Area to more fully encompass prime calving and insect-relief habitat within the NPR-A. Alternative B-1 would also create a 1.6-million-acre Peard Bay Special Area to protect haul-out areas and nearshore waters for marine mammals and habitat for waterbird and shorebird breeding, molting, staging, and migration. The boundary of the Colville River Special Area would not change, but its purpose would be modified to protect all raptors, rather than the original intent of protection for arctic peregrine falcons.

Alternative B-1 would make approximately 11.8 million acres of the NPR-A unavailable for oil and gas leasing. Approximately 3.1 million acres between Kuukpik Corporation lands in the east to Dease Inlet on the west would be unavailable for leasing. This area includes important calving and insect-relief areas for the Teshekpuk Caribou Herd, as well as important waterfowl and shorebird habitat and subsistence use areas, and encompasses and supersedes the current time-limited (2018) deferral for lands north and east of Teshekpuk Lake. Approximately 8.2 million acres in southwestern NPR-A would also be unavailable; they comprise remote lands with primitive recreation values as well as important calving and insect-relief habitat for the Western Arctic Herd. Other lands would be unavailable for leasing in Alternative B-1 to protect marine habitat and shorelines important for marine animals, waterfowl, and shorebirds. These are the major coastal waterbodies—Elson Lagoon, Dease Inlet, Admiralty Bay, Wainwright Inlet/Kuk River, Peard Bay, and Kasegaluk Lagoon as depicted on Map 2-2—and their associated barrier islands and, in the case of Peard Bay and Kasegaluk Lagoon, lands within 1 mile of those two waterbodies. Within the unavailable lands in this alternative, the BLM generally would not permit new non-subsistence permanent infrastructure (whether or not related to oil and gas activities) or exploratory drilling. There would be two exceptions to this prohibition. Following completion of appropriate NEPA analysis and subject to permit conditions, subsurface pipelines under the Wainwright Inlet/Kuk River and drilling and infrastructure necessary for exploration, development, production, and abandonment of valid existing NPR-A oil and gas leases could be permitted.

By not offering these lands for oil and gas leasing and restricting new non-subsistence permanent infrastructure, this alternative would also protect the wilderness characteristics of the lands. The alternative would allow temporary hunting, fishing, and trapping structures and access (e.g., motorboat, snowmobile [with adequate snow cover] and off-highway vehicle (OHV) use, and airplane use, including use of unimproved landing areas) throughout the entire NPR-A, provided that such use is consistent with the off-highway vehicle use designation (see Table 2-2) and would not detrimentally impact resources, particularly those resources sought to be protected in lands not offered for leasing.

Alternative B-1 would recommend congressional designation of all or portions of 12 rivers for inclusion in the National Wild and Scenic Rivers System. The Colville (where the BLM manages the riverbed and both banks in and above T6S, R17W, U.M.), Nigu, Etivluk, Ipnavik, Kuna, Kiligwa, Nuka, Awuna, Kokolik, and Utukok rivers and Driftwood and Carbon creeks would be recommended for wild river status.

Lands with particularly high surface resource values, such as stream, lake, and coastal riparian areas, would receive special protection. Table 2-2 and Table 2-3 identify protective measures associated with this alternative, and Map 2-2-1K depicts sensitive areas provided protection through the K series of stipulations.

2.3.2.2 Alternative B-2—Preferred Alternative

Alternative B-2, while reflecting some aspects of other alternatives, is similar to Alternative B-1, similarly emphasizing the protection of surface resources. It makes approximately 11.8 million acres of federally owned subsurface (nearly 52 percent of the total in the NPR-A) available for oil and gas leasing (Map 2-2-2). Of the lands currently deferred from leasing, some in the northwestern NPR-A would be made available for leasing in 2014 after expiration of the deferral described in Alternative A (Map 2-1). Other currently deferred lands near Teshekpuk Lake would not become available because, under this alternative, they would be unavailable for leasing. While this plan makes no decisions regarding a corridor for infrastructure associated with potential offshore development in the Chukchi or Beaufort seas, such a corridor could be accommodated in this alternative. This plan makes no decisions regarding the potential placement of a pipeline or any accompanying infrastructure within this corridor. It allows for an application to be filed, and it anticipates that such application would be subject to full NEPA review and decision. This infrastructure would not be allowed on lands where new nonsubsistence permanent infrastructure is prohibited, but all other lands would be available for application for pipelines and other infrastructure in support of potential offshore oil and gas development (see Figure 2-1). No provision of this alternative other than the prohibition of new non-subsistence infrastructure would directly or indirectly prohibit infrastructure in support of offshore development in the Chukchi or Beaufort seas.

Alternative B-2 would enlarge two existing Special Areas and create one new Special Area. It would add approximately 1.9 million acres to the Teshekpuk Lake Special Area (approximately 140,000 fewer acres than Alternative B-1) to protect caribou calving and insect-relief areas and waterbird and shorebird breeding, molting, staging, and migration habitats. The purpose of the Teshekpuk Lake Special Area would be expanded to include the protection of important caribou and shorebird habitat while continuing to protect waterbird habitat, which was the original purpose for the Special Area. Alternative B-2 would also add approximately 3.1 million acres to the Utukok River Uplands Special Area to more fully encompass prime calving and insect-relief habitat within the NPR-A and would create a 107,000-acre Peard Bay Special Area (as compared to Alternative B-1 under which the Peard Bay Special Area would be approximately 1.6 million acres) to protect haul-out areas and nearshore waters for marine mammals and a high use staging and migration area for shorebirds and waterbirds. The boundaries of the Colville River Special Area and Kasegaluk Lagoon Special Area would not change, but the purpose of the former would be modified to protect all raptors, rather than the original intent of protection for arctic peregrine falcons. Alternative B-2, unlike Alternative B-1, would not expand the Kasegaluk Lagoon Special area.

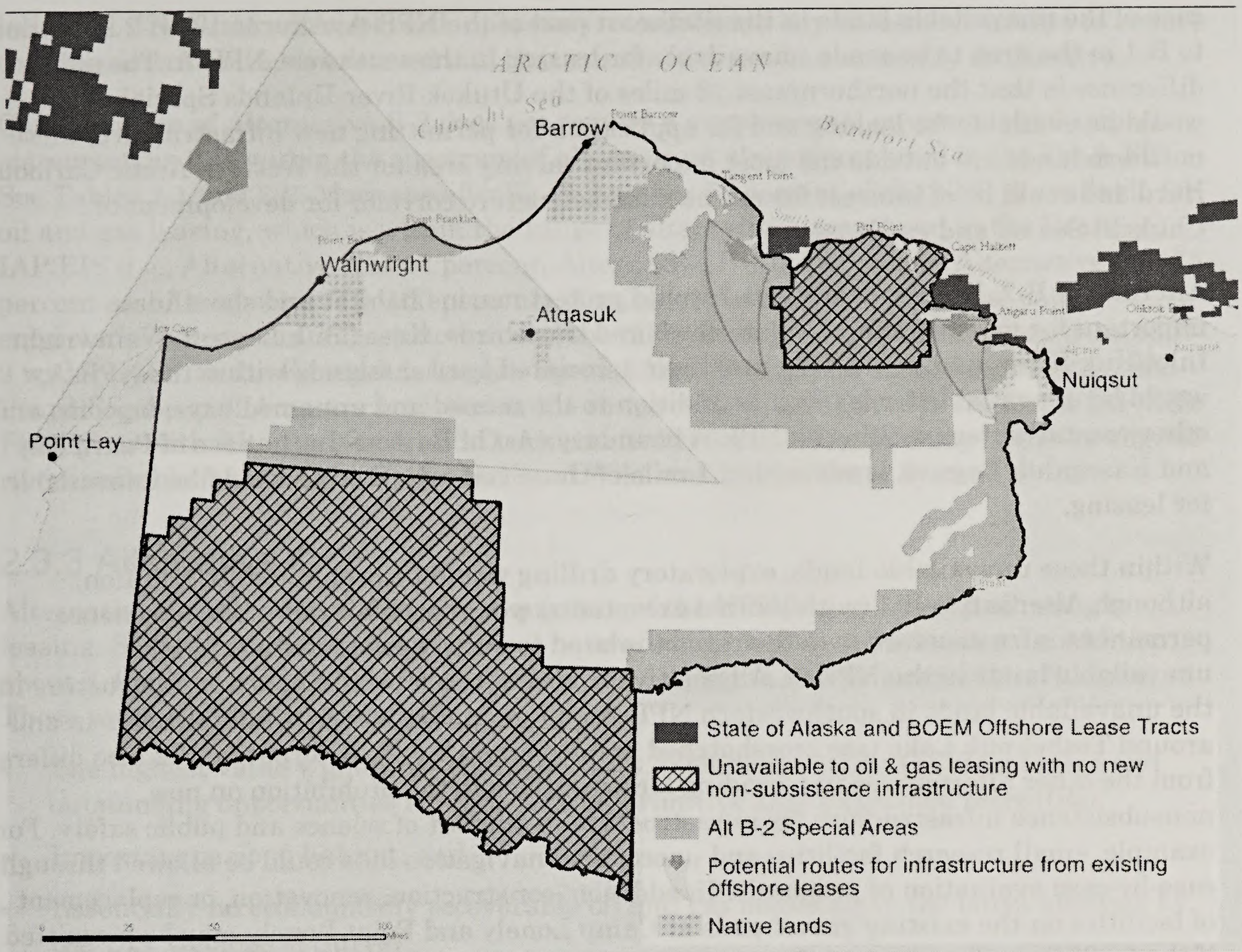
ARCTIC OCEAN
Chukchi Sea
Beaufort Sea
Point Barrow
Barrow
Tangent Point
Point Franklin
Wainwright
Atqasuk
Icy Cape
Point Lay
Smith Bay
Pitt Point
Cape Halkett
Atigaru Point
Oliktok Point
Alpine
Nuiqsut
0 25 50 100 Miles
State of Alaska and BOEM Offshore Lease Tracts
Unavailable to oil & gas leasing with no new non-subsistence infrastructure
Alt B-2 Special Areas
Potential routes for infrastructure from existing offshore leases
Native lands

Figure 2-1. Illustration of some potential routes for infrastructure in support of development of existing offshore leases consistent with the preferred alternative

Alternative B-2 would make approximately 11 million acres of the NPR-A unavailable for oil and gas leasing. Approximately 3.1 million acres between Atigaru Point (and waters within NPR-A near the point) in the east to Ukpeaġvik Iñupiat Corporation (Barrow village corporation) lands on the west would be unavailable for leasing. This area includes important calving and insect-relief areas for the Teshekpuk Caribou Herd, as well as important waterfowl and shorebird habitat and subsistence use areas, and encompasses and supersedes the current time-limited (2018) deferral for lands north and east of Teshekpuk Lake.

Alternative B-2 is similar to B-1 in the area to be made unavailable for leasing in the Arctic Coastal Plain east of Barrow; the differences are that Alternative B-2 makes lands currently under lease and near lands currently under lease in northeastern NPR-A near Fish Creek available and makes lands between Barrow and Dease Inlet/Admiralty Bay unavailable.

Approximately 7.3 million acres in the southwestern NPR-A including much of the Utukok River Uplands Special Area and the upper-most portion of the Colville River Special Area, would also be unavailable; they include important calving and insect-relief habitat for the Western Arctic Caribou Herd and remote lands with primitive recreation values. As in the case of the unavailable lands in the northeast part of the NPR-A, Alternative B-2 is similar to B-1 in the area to be made unavailable for leasing in the southwest NPR-A. The only difference is that the northernmost 18 miles of the Utukok River Uplands Special Area would be available for leasing and for application for permitting new infrastructure; these northern lands are outside the most important calving area for the Western Arctic Caribou Herd and could be of interest for use as a infrastructure corridor for development of Chukchi Sea oil and gas leases.

Alternative B-2, like Alternative B-1 would protect marine habitat and shorelines important for marine animals, waterfowl, and shorebirds. Kasegaluk Lagoon, Wainwright Inlet/Kuk River, and Peard Bay, and their associated barrier islands within the NPR-A, would be unavailable for leasing, in addition to the named and unnamed bays, lagoons, and other coastal waters within the NPR-A boundary east of Barrow. In the case of Peard Bay and Kasegaluk Lagoon, lands within 1 mile of those two waterbodies would be unavailable for leasing.

Within these unavailable lands, exploratory drilling would be prohibited. In addition, although Alternative B-1 (with limited exceptions) would prohibit new non-subsistence permanent infrastructure (whether or not related to oil and gas activities) in all unavailable lands in the NPR-A, Alternative B-2 would only prohibit such infrastructure in the unavailable lands in southwestern NPR-A and in approximately 1 million acres in and around Teshekpuk Lake (see crosshatched areas on map 2-2-2). Alternative B-2 also differs from the other alternatives in providing for exceptions to the prohibition on new nonsubsistence infrastructure for infrastructure in support of science and public safety. For example, small research facilities and unoccupied navigation aids could be allowed through case-by-case evaluation of proposals. In addition, construction, renovation, or replacement of facilities on the existing gravel pads at Camp Lonely and Point Lonely may be permitted if the facilities will promote safety or environmental protection. The alternative also would allow temporary hunting, fishing, and trapping structures and access (e.g., motorboat, snowmobile [with adequate snow cover] and off-highway vehicle [OHV] use, and airplane use, including use of unimproved landing areas) throughout the entire NPR-A, provided that such use is consistent with the off-highway vehicle use designation (see Table 2-2) and would not detrimentally impact resources, particularly those resources sought to be protected in lands not offered for leasing.

Alternative B-2 also would differ from Alternative B-1 in not recommending congressional Wild and Scenic River designation. Though the BLM would not find the 12 eligible rivers considered in detail in this plan to be suitable for inclusion in the National Wild and Scenic Rivers System at this time, it would still manage all 12 rivers to protect their free flow, water quality, and outstandingly remarkable values using other means, thereby providing an alternative method of protection that preserves Congress's option to pursue Wild and Scenic River designation if warranted in the future.

Lands with particularly high surface resource values, such as stream, lake, and coastal riparian areas, would receive special protection. Table 2-2 and Table 2-3 identify protective measures associated with this alternative, and Map 2-2-2K depicts sensitive areas provided protection through the K series of stipulations. Under Alternative B-2, the BLM would implement a management approach that requires industry to fund baseline studies, monitoring, and adaptive management programs. The type and scale of such studies will be determined based on the characteristics of the proposed infrastructure projects and locations. The BLM will work with operators to coordinate any necessary surveys to ensure that consistent methods are used and that surveys are not unnecessarily duplicative.

Consideration of Alternative B-2 does not require a supplemental environmental impact statement, as it is within the spectrum of alternatives already analyzed in the Draft EIS. See Tables 2-1 and 2-2. More specifically, B-2 makes 52 percent of the NPR-A available for oil and gas leasing, which is within the range of alternatives considered in the Draft IAP/EIS (i.e., Alternative A is 57 percent, Alternative B-1 is 48 percent, Alternative C is 75 percent and Alternative D is 100 percent). Similarly, the restrictions on new non-subsistence permanent infrastructure and the differences between Alternatives B-1 and B-2 with respect to the Kasegaluk Lagoon Special Area, Teshekpuk Lake Special Area, and Peard Bay Special Area are analyzed in the range of the alternatives in the Draft IAP/EIS. Finally, as with Alternatives A and D, Alternative B-2 would not find any of the 12 eligible rivers suitable for inclusion in the National Wild and Scenic Rivers System.

2.3.3 Alternative C

Alternative C makes more than three-quarters of the NPR-A available for oil and gas leasing. Selected coastal areas would not be available for oil and gas leasing. In addition, about 4.4 million acres would be unavailable for leasing in the far south of the Reserve. These southern lands possess:

- The highest value wilderness characteristics, including qualities of naturalness and outstanding opportunities for solitude and primitive and unconfined recreation;
- Important caribou habitat; and
- Essentially no economically recoverable oil and gas according to the latest analysis by the U.S. Geological Survey.

The alternative would provide surface protections from oil and gas development elsewhere in the Reserve, most notably near Teshekpuk Lake (Maps 2-3 and 2-3K). It would not make currently deferred lands available until after the expiration of the deferrals described in Alternative A. While this plan makes no decisions regarding a corridor for infrastructure associated with offshore development in the Chukchi Sea, such a corridor could be accommodated in this alternative, subject to appropriate conditions developed through a NEPA process. This infrastructure would not be allowed, however, on lands where new non-subsistence permanent infrastructure is prohibited.

The alternative would make 17.9 million acres (76 percent of federal subsurface lands in the NPR-A) available for leasing. Oil and gas leases would not be offered (see Map 2-3):

- within approximately 4.4 million acres in the extreme southern part of the Reserve, thus protecting some of the highest value wilderness recreation potential in the NPR-A, as well as some of the Western Arctic Herd's calving and insect-relief area in an area of extremely low oil and gas potential; and
- in the existing Kasegaluk Lagoon Special Area, a newly designated Peard Bay Special Area, and in major coastal waterbodies (Elson Lagoon, Dease Inlet, Admiralty Bay, and Wainwright Inlet/Kuk River) to protect habitat important for marine mammals and birds.

Exploratory drilling and non-subsistence permanent infrastructure would not be allowed in the lands unavailable for leasing in the southern NPR-A and in the Kasegaluk Lagoon and

Peard Bay Special Areas or within the above listed waterbodies, with the exception of a subsurface pipeline under the Wainwright Inlet/Kuk River or for infrastructure necessary for exploration, development, production, and abandonment of valid existing NPR-A oil and gas leases. The alternative would allow temporary hunting, fishing, and trapping structures or access (e.g., motorboat, snowmobile [with adequate snow cover] and OHV use, and airplane use, including use of unimproved landing areas) throughout the entire NPR-A, provided that such use is consistent with the Off-highway Vehicle use designation (see Table 2-2) and such use would not detrimentally impact resources, particularly those resources sought to be protected in lands not offered for leasing.

The alternative would create a 107,000-acre Peard Bay Special Area to protect haul-out areas and nearshore waters for marine mammals and a high use staging and migration area for shorebirds and waterbirds. It would enlarge the Teshekpuk Lake Special Area by approximately 120,000 acres and the Utukok River Uplands Special Area by approximately 470,000 acres to more fully encompass caribou calving habitat. It would modify the purposes of the Teshekpuk Lake Special Area and the Colville River Special Area in the same way as Alternatives B-1 and B-2. Alternative C also would recommend the Colville River (where BLM manages the river bed and both banks in and above T6S, R17W, U.M.), the Utukok River (within the NPR-A), and the Kiligwa River for designation by Congress as additions to the National Wild and Scenic Rivers System with scenic status. To further enhance the potential for oil and gas development, the BLM would, as funds are available, develop a plan of exploration and evaluation of gravel sources suitable for construction of roads and pads necessary for development. Such exploration and evaluation may be conducted in cooperation with other agencies or with private industry.

As with Alternatives A, B-1, and B-2, lands with particularly high surface resource values, especially those within Special Areas, would receive special protection. Of particular note, much land near Teshekpuk Lake would allow leasing, but preclude construction of production pads. This may require directional/horizontal drilling for substantial distances to reach oil and gas resources. Table 2-2 and Table 2-3 identify protective measures associated with this alternative, and Map 2-3K depicts sensitive areas provided protection through the K series of stipulations.

2.3.4 Alternative D

Alternative D would maximize leasing opportunities within the NPR-A (Maps 2-4 and 2-4K). All lands would be made available for oil and gas leasing, though leasing in lands currently deferred from leasing (see Alternative A) would not be offered for lease until the deferrals have expired. While this plan makes no decisions regarding a corridor for infrastructure associated with offshore development, such a corridor could be accommodated in this alternative, subject to appropriate conditions developed through a NEPA process. As in the other alternatives, lands with particularly high surface resource values, especially those within Special Areas, would receive special protection, though several stipulations common to other alternatives to protect biological resources near Teshekpuk Lake would not apply or would be less restrictive in this alternative. (For a more detailed description of protections that would be ensured through leasing stipulations or permit requirements under Alternative D, see Table 2-3, particularly the "K" stipulations.) As in Alternative C, to further enhance the potential for oil and gas development, the BLM would, as funds are available, develop a plan of exploration and evaluation of gravel sources suitable for construction of roads and pads necessary for development. Such exploration and evaluation may be conducted in cooperation with other agencies or with private industry. The alternative would allow temporary hunting, fishing, and trapping structures or access (e.g., motorboat, snowmobile [with adequate snow cover] and OHV use, and airplane use, including use of unimproved landing areas) throughout the entire NPR-A, provided that such use is consistent with the Off-highway Vehicle use designation (see Table 2-2) and such use would not detrimentally impact resources. There would be no expansion of Special Areas, no new designation of Special Areas, no prohibition of new non-subsistence permanent infrastructure, and BLM would not recommend any rivers for Wild and Scenic River designation by Congress. Table 2-2 and Table 2-3 identify other protective measures associated with this alternative, and Map 2-4K depicts sensitive areas provided protection through the K series of stipulations.

Table 2-1. Major land allocation summary

Land allocation	Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
Lands that could be offered for oil and gas leasing (acres)	13 million (57% of NPR-A subsurface available; 1.57 million deferred until 2014; 425,000 deferred until 2018)	11 million (48% of NPR-A subsurface; current deferrals honored until expiration)	11.8 million (52% of NPR-A subsurface; current deferrals honored until expiration)	17.9 million (76% of NPR-A subsurface; current deferrals honored until expiration)	22.8 million (100% of NPR-A subsurface; current deferrals honored until expiration)
Number of Special Areas and acres	4 (8.3 million acres) TLSA: 1.75 million CRSA: 2.44 million URUSA: 3.97 million KLSA: 97,000 acres	5 (15.5 million acres) TLSA: 3.76 million CRSA: 2.44 million URUSA: 7.06 million KLSA: 364,000 PBSA: 1.6 million	5 (13.35 million acres) TLSA: 3.65 million CRSA: 2.44 million URUSA: 7.06 million KLSA: 97,000 PBSA: 107,000	5 (9.0 million acres) TLSA: 1.87 million CRSA: 2.44 million URUSA: 4.44 million KLSA: 97,000 PBSA: 107,000	4 (8.3 million acres) TLSA: 1.75 million CRSA: 2.44 million URUSA: 3.97 million KLSA: 97,000
Number of Wild and Scenic River recommendations	0	12 Wild River designation: Colville (where the BLM manages the bed and both banks), Nigu, Etivluk, Ipnavik, Kuna, Kiligwa, Nuka, Awuna, Kokolik, and Utukok Rivers and Driftwater and Carbon Creeks within the NPR-A	0	3 Scenic River designation: Colville (where the BLM manages the bed and both banks), Kiligwa, and Utukok Rivers within the NPR-A	0

TLSA = Teshekpuk Lake Special Area
CRSA = Colville River Special Area
URUSA = Utukok River Uplands Special Area
KLSA = Kasegaluk Lagoon Special Area
PBSA = Peard Bay Special Area

Table 2-2. Management actions (other than land allocations, stipulations, and required operating procedures/best management practices)*

Management action	Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
Visual resource management (See Map 2–5)	**Within the Northwest NPR-A only: VRM-I:** The lands along the Colville River. (134,000 acres) **VRM-II:** none **VRM-III:** Identified estuarine areas and lands along the other 21 rivers eligible for designation as Wild and Scenic Rivers. These VRM classes apply to all lands within 3 miles of the banks of all identified waterbodies. (4.9 million acres) **VRM-IV:** The remainder of the Northwest NPR-A planning area. (3.7 million acres)	**VRM I:** A corridor extending approximately 0.5 mile from the bank of 12 rivers recommended for designation as Wild and Scenic Rivers. (655,000 acres) **VRM II:** Teshekpuk Lake, Wainwright Inlet, and lands in the southern foothills area more than 0.5 mile and less than 5 miles from 11 rivers recommended as Wild and Scenic Rivers. (3.6 million acres)	**VRM II:** Wainwright Inlet and those areas where new non-subsistence infrastructure is not allowed	**VRM I:** A corridor extending approximately 0.5 mile from the bank of three rivers recommended for designation as a Wild and Scenic River (263,000 acres)	**VRM IV:** All of NPR-A. (22.5 million surface acres)
		VRM III: Except for those areas designated as VRM I or VRM II, rivers and lands within 3 miles of segments of rivers identified as eligible for Wild and Scenic River designation in this IAP, the 2003 Northwest NPR-A IAP, or the 2008 Northeast NPR-A Supplemental IAP; also Kasegaluk Lagoon, Peard Bay, Elson Lagoon, Dease Inlet, and Admiralty Bay and lands within 3 miles of those waterbodies (7.1 million acres) **VRM IV:** The rest of the NPR-A. (11.2 million acres)	**VRM III:** Except for those areas designated as VRM II, rivers and lands within 3 miles of segments of rivers identified as eligible for Wild and Scenic River designation in this IAP, the 2003 Northwest NPR-A IAP, or the 2008 Northeast NPR-A Supplemental IAP; also Kasegaluk Lagoon, Peard Bay, Elson Lagoon, Dease Inlet, and Admiralty Bay and lands within 3 miles of those waterbodies (5.8 million acres) **VRM IV:** The rest of the NPR-A. (8.4 million acres)	**VRM III:** Except for those areas designated as VRM I, rivers and lands within 3 miles of segments of rivers identified as eligible for Wild and Scenic River designation in this IAP, the 2003 Northwest NPR-A IAP, or the 2008 Northeast NPR-A Supplemental IAP; also Kasegaluk Lagoon, Peard Bay, Elson Lagoon, Dease Inlet, and Admiralty Bay and lands within 3 miles of those waterbodies (7.6 million acres) **VRM IV:** The rest of the NPR-A. (14.7 million acres)	

Table 2-2. Management actions (other than land allocations, stipulations, and required operating procedures/best management practices)*

<table>
<tr><th>Management action</th><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td rowspan="5">Off-highway vehicle use designation</td><td rowspan="5">Within the Northwest NPR-A only: Limited: recreational OHV use is confined to winter use of snow machines and other low ground-pressure vehicles. No summer recreational use of OHVs is permitted. The summer use of OHVs (including all-terrain vehicles and airboats) to support traditional subsistence activities and access is allowed. The use of airboats during the summer is limited to streams, lakes, and estuaries that are seasonably accessible by motorboat. To prevent impacts to soils, water quality, vegetation, and wildlife (in particular nesting waterfowl), airboat use in areas of seasonal flooding of tundra and temporary shallow waters adjacent to streams, lakes, and estuaries is prohibited.</td><td colspan="4">Limited: To reduce damage to the tundra and soils, the OHV area designation is limited and inter-village travel and airboat use is subject to restrictions.
OHVs include all-terrain vehicles, utility vehicles, motorcycles, snowmobiles, and other wheeled or tracked vehicles designed for travel off developed roads.
High-clearance vehicles include pick-up trucks, SUVs, crossovers, and other vehicles with sufficient clearance to not get high-centered.</td></tr>
<tr><td colspan="4">Casual or non-subsistence travel use:
OHV use is limited to vehicles with a gross vehicle weight rating of 2,000 pounds or less, and to times when frost and snow cover is at sufficient depths to protect the tundra.</td></tr>
<tr><td>Inter-village travel:
Use of OHVs for travel between villages is limited to times when frost and snow cover is at sufficient depths to protect the tundra. Use of high-clearance vehicles is not allowed.</td><td colspan="3">Inter-village travel:
Use of OHVs and high-clearance vehicles for travel between villages is limited to times when frost and snow cover is at sufficient depths to protect the tundra.</td></tr>
<tr><td colspan="4">Airboat use:
Non-subsistence use of airboats is not permitted, except as authorized as part of a spill response and prevention plan or for other activities specifically authorized by the authorized officer in which the impacts to the environment would be minor or negligible. The use of airboats is limited to streams, lakes, and estuaries that are seasonably accessible by motorboat. To prevent impacts to soils, water quality, vegetation, and wildlife (in particular nesting waterfowl), airboat use in areas of seasonal flooding of tundra and temporary shallow waters adjacent to streams, lakes, and estuaries is prohibited.</td></tr>
<tr><td colspan="4">Subsistence use:
Year-round use of OHV to support subsistence activities and access is allowed. The use of airboats is limited to streams, lakes, and estuaries that are seasonably accessible by motorboat. To prevent impacts to soils, water quality, vegetation, and wildlife (in particular nesting waterfowl), airboat use in areas of seasonal flooding of tundra and temporary shallow waters adjacent to streams, lakes, and estuaries is prohibited.</td></tr>
<tr><td>Inventory potential NPR-A gravel sources</td><td colspan="2">No comparable provision.</td><td colspan="3">The BLM would, as funds are available, develop a plan of exploration and evaluation of gravel sources suitable for construction of roads and pads necessary for development. Such exploration and evaluation may be conducted in cooperation with other agencies or with private industry.</td></tr>
</table>

Table 2-2. Management actions (other than land allocations, stipulations, and required operating procedures/best management practices)*

Management action	**Alternative A**	**Alternative B-1**	**Alternative B-2 Preferred Alternative**	**Alternative C**	**Alternative D**
Spectacled and Steller's eider protections	To address concerns relevant to protection of spectacled and Steller's eiders, both of which are listed as threatened under the ESA, the BLM is adopting the following measures put forward by the USFWS in its "Biological Opinion for the Northern Planning Areas of the National Petroleum Reserve-Alaska" issued in July 2008. 1. The BLM will provide the USFWS with a copy of the compliance-monitoring plan for oil and gas development within the planning area. To ensure protection of listed eiders, special emphasis shall be placed on compliance monitoring for Stipulations/ Required Operating Procedures A-1–7, D-2, E-9–12, E-14, E-17, E-18, F-1, K-1–3, K-6, and K-8. All acts of noncompliance or nonconformance to the required operating procedures/best management practices, stipulations, and enforceable elements of assumptions mentioned above will be reported in writing to the Field Supervisor, U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, 101 12th Ave., Fairbanks, AK 99701. In the event that noncompliance/ nonconformance issues arise, BLM and the USFWS will cooperatively develop a strategy to eliminate the problem. 2. The BLM will continue, funding permitting, to contribute to monitoring efforts for threatened eiders and BLM special status species in the NPR-A to allow the BLM and USFWS to better evaluate abundance, distribution, and population trends of listed eiders and other special status species. 3. The BLM will work, funding permitting, with the USFWS and other federal and State agencies in implementing recovery actions identified in the spectacled and Steller's eider recovery plans. Research to determine important habitats, migration routes, and wintering areas of spectacled and Steller's eiders would be an important step toward minimizing conflicts with current and future North Slope oil/gas activities. *[Note: In Alternative A, this requirement only applies to Northeast NPR-A.]*				
Research of goose molting habitat near Teshekpuk Lake	*[Note: This provision is not part of Alternatives B-1 and B-2, the second paragraph only applies to Alternative A, and the third paragraph only applies to Alternatives A and C.]* 1. Prior to any authorization of construction of permanent facilities in the portion of the Goose Molting Area deferred from leasing for 10 years in the 2008 Northeast NPR-A Supplemental IAP Record of Decision, the BLM, after conferring with appropriate federal, State, and North Slope Borough agencies, would complete a research study of the effects of disturbance on molting brant and other geese that utilize the lakes north of Teshekpuk Lake. After conferring with appropriate federal, State, and North Slope Borough agencies, the BLM will develop this research study to include at least 3 years of data collection and focus on (1) providing baseline data for detection and/or measurement of disturbance, 2) identifying significant development-related disturbance factors, (3) evaluating consequences to geese from disturbance within the Goose Molting Area considering relevant stipulations and required operating procedures, and (4) identifying additional mitigation measures to protect molting geese that may be considered necessary as a result of the study, including recommendations for appropriate placement of permanent facilities based on the study's identification of development-related disturbance factors. 2. In addition, the study results would be used to identify specific location(s) of facility(ies) within the approximately 5,000-acre parcel of land in T15N, R4W, U.M. and T16N, R3W and R4W, U.M. (as depicted on Map 2-1K) within the Goose Molting Area Lease Tracts F and G. 3. Any additional mitigation practices that are identified as a result of this study that are necessary to achieve the goal of lease stipulation K-4a shall be implemented or agreed to prior to authorization of construction.				

Table 2-2. Management actions (other than land allocations, stipulations, and required operating procedures/best management practices)*

<table>
<tr><th>Management action</th><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>Public health consultation</td><td>To help ensure the proper consideration of potential public health impacts, the BLM will consult with agencies with recognized expertise in Alaska Native public health and health impact assessment on major development proposals to gain information about their potential public health impacts. At a minimum, the agencies to be consulted will include the North Slope Borough Health Department and the Alaska Native Tribal Health Consortium. The BLM may also consult with other sources of recognized public health expertise.</td><td colspan="4">To help ensure the proper consideration of potential public health impacts, the BLM will consult with agencies with recognized expertise in Alaska Native public health and health impact assessment on major development proposals to gain information about their potential public health impacts and to identify mechanisms to avoid, minimize, or mitigate those impacts. At a minimum, the agencies to be consulted will include the North Slope Borough Health Department, the Alaska Department of Health and Social Services, and the Alaska Native Tribal Health Consortium. The BLM may also consult with other sources of recognized public health expertise.</td></tr>
</table>

* Under Alternative A, some provisions common to all alternatives did not apply in one of the currently planned areas (Northeast and Northwest NPR-A) and none of the provisions under Alternative A applied to the unplanned areas. See bracketed statements in cells in the table for additional clarification.

2.3.5 Stipulations and Required Operating Procedures/Best Management Practices

In addition to the land allocation decisions regarding what portions of the planning area would be made available to oil and gas leasing, the alternatives differ in the protective measures that would be imposed on activities permitted by the BLM in the NPR-A. The protective measures in Alternative A are those adopted in the Northwest NPR-A IAP Record of Decision signed on January 22, 2004, the Northeast NPR-A Supplemental IAP Record of Decision signed on July 16, 2008, and the 2008 Colville River Special Area Management Plan Decision Record signed on July 18, 2008. Alternatives B-1 through D have their own protective measures, many of which are similar to, or the same as, those adopted in the Northeast NPR-A Supplemental IAP Record of Decision, the most recently completed NPR-A land use plan; under Alternatives B-1 through D, the measures would apply to all of NPR-A rather than just the Northeast NPR-A planning area

Protective measures are of two types—stipulations and required operating procedures in Alternative A, or stipulations and best management practices in the other alternatives.

Stipulations

Stipulations are attached to the lease prior to issuance, as appropriate. As part of a lease contract, lease stipulations are specific to the lease. All oil and gas activity permits issued to a lessee will comply with the lease stipulations appropriate to the activity (e.g., exploratory drilling or production pad construction) under review. They describe objectives for protection of certain resources and management of certain activities in NPR-A and the means—the "requirements/standards"—by which BLM considers that these objectives will be achieved.

A stipulation included in an oil and gas lease shall be subject to a waiver (permanent exemption to a stipulation on a lease), exception (a one-time exemption to a lease stipulation determined on a case-by-case basis), or modification (a change to a lease stipulation either temporarily or for the life of the lease) only if the authorized officer determines that the factors leading to the stipulation's inclusion in the lease have changed sufficiently to make the protection provided by the stipulation no longer justified and if the proposed operation would still meet the objective stated for the stipulation.

While the BLM may grant a waiver, exception, or modification of a stipulation through the permitting process, it may also impose additional requirements through permitting terms and conditions to meet the objectives of any stipulation if the authorized officer considers such requirements are warranted to protect the land and resources pursuant to the BLM's responsibility under relevant laws and regulations. (See the discussion of Required Operating Procedures and Best Management Practices below, particularly the discussion of their performance-based aspect.) Also, while stipulations apply to oil and gas leases, applicants for BLM authorizations should understand that the objectives of the stipulations are equally valid for oil and gas activities taking place off of the lease and for analogous non-oil and gas lease-related activities and that through permitting the BLM may impose terms and conditions, likely analogous to the "requirements/standards" of the stipulations, to achieve these objectives. For example, an applicant for a non-lease-related construction project would still have to meet the objectives included in Stipulation E-3 to protect free passage of marine and anadromous fish and protect subsistence use and access if such a provision was established as a permit condition, thus affecting design and placement of causeways, docks, and artificial islands. For activities not associated with an oil and gas lease, the stipulations in this IAP/EIS should be understood to function similarly to required operating procedures or best management practices.

Required Operating Procedures and Best Management Practices

Required operating procedures as presented in Alternative A are a product of the 2004 Northwest NPR-A Record of Decision and the 2008 Northeast NPR-A Supplemental IAP Record of Decision. Like stipulations, they describe objectives for protection of certain resources and management of certain activities in NPR-A and the means—the "requirements/standards"—by which BLM considers that these objectives might be achieved. "Best management practices" is the term that the BLM is using instead of required operating procedures in Alternatives B-1, B-2, C, and D. The required operating procedures and best management practices describe the protective measures that the BLM today would likely impose on applicants for authorization for use of the public lands and provide applicants with notice of at least some of the land management objectives that the BLM will seek to achieve during the permitting process and the possible means, though not necessarily the entire extent of the means, by which BLM may seek to achieve those objectives. In the context of this IAP/EIS, the required operating procedures/best management practices also provide a basis for analyzing the potential impacts of the alternatives.

Required operating procedures/best management practices are guidance for future performance-based requirements to obtain BLM authorization in NPR-A. Performance-based required operating procedures/best management practices allow the BLM at the permitting stage to better meet the stated objectives by utilizing (1) the latest and best understanding of the North Slope environment (including changes associated with a warming climate) and possible impacts to the environment, (2) the latest advances in technology and techniques relevant to North Slope oil and gas activities, and (3) more site- and project-specific information that is available at the permit stage. If, after experience or additional study, the BLM concludes that a required operating procedure/best management practice requirement/standard is not achieving or is unlikely to achieve a protective objective when applied to a specific future on-the-ground action or would not do so as well as the use of recently proven technology or techniques, the BLM could impose other restrictions to meet the objective.

Required operating procedures/best management practices apply to both oil and gas activities and non-oil and gas activities. Any applicant requesting authorization for an activity from the BLM will have to address the applicable required operating procedures/best management practices either before submitting the application (e.g., subsistence consultation, surveys), as part of the application proposal (e.g., including in the proposal statements that the applicant will meet the objective of the required operating procedure/best management practice and describe how the applicant intends to achieve that objective), or as a term imposed by the BLM in a permit. Requirements that are met prior to submission of the application, as well as procedures, practices, and design features that are an integral part of a proposal, would not need to be required as a term of a permit. Note that at the permitting stage, the BLM's authorized officer would not include those required operating procedures/best management practices that, because of their geographic or other inapplicability, are not relevant to a specific permit application. Note also that at the permit stage the authorized officer may establish additional requirements that would be warranted to protect the land and resources pursuant to the BLM's responsibility under relevant laws and regulations. Some protections described in Table 2-2 that apply directly to oil and gas activities may be adapted at the permit stage for non-oil and gas activities if the on-the-ground activities are similar and pose similar environmental risks. Whether imposed as a condition of a permit or as a lease stipulation, requirements are binding upon the applicant for authorization.

The stipulations and required operating procedures/best management practices of all the alternatives are presented in Table 2-3. The table provides the easiest means to compare the stipulations and required operating procedures/best management practices among the alternatives.

2.4 Alternatives Considered But Eliminated From Detailed Analysis

The BLM has considered alternatives in addition to those listed in section 2.3, but has determined to eliminate them from further consideration for the reasons provided below.

2.4.1 Recommending Wilderness Designation by Congress

The BLM has determined not to analyze in detail an alternative that would recommend Wilderness designation within the planning area because it is beyond the scope of this planning effort. Consistent with Secretary Salazar's June 1, 2011, memorandum to the Director of the BLM and BLM Instruction Memorandum No. 2011-154, dated July 25, 2011, however, the BLM has considered in this plan a full range of reasonable alternatives with respect to lands with wilderness characteristics, including alternatives that would protect wilderness characteristics in a substantial portion of lands that contain them. The BLM may identify and/or make recommendations regarding possible areas appropriate for Wilderness designation independent of this planning effort.

2.4.2 Designating Wild Lands

Pursuant to Secretary Salazar's June 1, 2011, memorandum to the Director of the BLM and BLM Instruction Memorandum No. 2011-154, the BLM is no longer considering designation of Wild Lands in its land use planning process, as it previously had done pursuant to Secretarial Order 3310, issued on December 22, 2010. Accordingly, in this plan the BLM does not analyze in detail an alternative that would designate Wild Lands. However, consistent with these memoranda, the BLM has considered in this plan a full range of reasonable alternatives with respect to lands with wilderness characteristics, including alternatives that would protect wilderness characteristics in a substantial portion of lands that contain them.

2.4.3 Recommendation for Legislation to Allow Hardrock and Coal Mining

The NPRPA, as amended, and its implementing regulations, require oil and gas leasing in the NPR-A and the protection of surface values to the extent consistent with exploration and development of oil and gas. Consistent with this purpose, the law also withdraws the NPR-A from all other forms of entry and disposition under the public land laws, including the mining laws. The BLM has determined not to analyze in detail an alternative recommending legislation to lift the existing statutory withdrawal from the mining laws because hardrock and coal mining would neither further oil and gas leasing nor protect surface values consistent with oil and gas exploration and development.

2.4.4 Reduce or Eliminate Special Areas

The Alaska Miners Association suggested eliminating or reducing the size of the existing Special Areas. Special Area designation does not itself impede oil and gas development. Special Areas, rather, indicate to managers and the public the importance of certain lands and the need to consider carefully the appropriate protection of surface resources consistent with oil and gas activities. Recent plans have expanded, rather than reduced the size and number of Special Areas to better reflect the BLM's understanding of the significance of these areas, and no information has come to the BLM's attention that would indicate that current Special Areas or portions of Special Areas do not meet the criteria set out in the NPRPA—i.e., that they fail to contain "significant subsistence, recreational, fish and wildlife, or historical or scenic value." Because reducing the size or eliminating Special Areas does not meet the purpose and need of this plan to either facilitate oil and gas leasing or protect surface resources, and no information has come to the BLM's attention that indicates that the existing Special Areas do not meet the statutory criteria of holding significant resources, the BLM has determined not to analyze in detail an alternative that reduces or eliminates any Special Area.

2.4.5 Determining Wild and Scenic River Suitability in the Northern Part of NPR-A

Detailed analysis of an alternative making Wild and Scenic River suitability determinations for streams in the previously planned northern portions of NPR-A is not included in this IAP/EIS. The BLM conducted a review of Wild and Scenic River eligibility and suitability in the 1998 Northeast IAP/EIS and in the 2003 Northwest NPR-A IAP/EIS. It found 22 rivers to be eligible. The BLM found in its Northeast NPR-A Final IAP/EIS that: "Without the support and assistance of local interests and other land owners/managers, the Colville River is unmanageable and, therefore, unsuitable as a component of the WSR system." It reiterated the above statement regarding the Colville River in its Final IAP/EIS for the Northwest NPR-A and noted that it was able to provide protection for all eligible rivers through methods other than Wild and Scenic River designation. These methods included setbacks from the rivers and deferrals from leasing. The BLM has reviewed and considered all of the relevant information available since its earlier analyses and has found no changes in factors relevant to Wild and Scenic River designation. The 22 rivers continue to meet the criteria for eligibility and BLM remains able to provide protection for these streams through methods other than Wild and Scenic River designation. The BLM concludes that there is no new information that suggests that the prior conclusions in the 1998 Northeast and 2003 Northwest IAP/EIS and their respective record of decisions (1998 and 2004) should be reconsidered or modified with respect to Wild and Scenic River suitability.

2.4.6 Recommending Establishment of a National Wildlife Refuge in All or Part of NPR-A

Some commenters suggested that administrative jurisdiction over all or a significant part of the NPR-A should be transferred to the U.S. Fish and Wildlife Service for management as part of the National Wildlife Refuge System. This would require congressional action and is beyond the scope of this planning effort. Alternatives B-1 and B-2 would address the wildlife conservation interests that are a basis for commenters' suggestions by expanding existing Special Areas and creating a new Special Area for the purposes of wildlife protection, most of which would be unavailable for oil and gas leasing consistent with the NPRPA. Also, in order to achieve the purposes of any Special Areas, the BLM may confer with and/or otherwise invoke the resources and expertise of other federal, State, and local agencies or tribes to manage certain resources or activities. This could include cooperative agreements ranging from agreements for technical assistance to an agreement whereby another federal, State, or local agency or a tribe could assist in the management of some resources and/or lands. However, any such management would continue to be subject to, and consistent with, the BLM's underlying statutory and regulatory requirements for the management of such Special Areas. In light of the analysis of protective management alternatives that would have essentially the same environmental consequences as that which would be provided by U.S. Fish and Wildlife Service management under the National Wildlife Refuge System, and because a transfer to the system is beyond the scope of this planning effort, the BLM has determined not to analyze in detail a separate alternative that would designate a wildlife refuge.

2.4.7 Prohibiting Infrastructure in Support of Chukchi Sea Oil and Gas Leases

The purposes of this plan include providing for an opportunity, subject to appropriate conditions, to construct necessary onshore infrastructure to bring oil and gas resources from leases in the Chukchi Sea to the Trans-Alaska Pipeline System. Development of Chukchi Sea oil and gas resources, considered among the most promising in the Nation, would not only help to meet the Nation's energy needs, but oil and gas infrastructure across the NPR-A would make it more economical to develop the NPR-A's oil and gas resources. An alternative that would not provide for such infrastructure would be inconsistent with the purpose of this plan and, therefore, outside its scope.

2.5 Monitoring and Inventory

Monitoring and inventory will be conducted:

- to better understand the NPR-A environment,
- to ensure compliance with lease, permit, and other authorization requirements, and
- to measure the effectiveness of protective measures required in leases, permits and other authorizations.

Multiple government and private parties conduct inventorying and monitoring to understand the environment. See the North Slope Science Initiative's website[1] for a list of ongoing projects by various parties. The BLM conducts compliance monitoring. Under the preferred alternative, effectiveness monitoring would be conducted by private or government parties; the lessee, permittee, or other party with a BLM authorization would be responsible for funding effectiveness monitoring.

The BLM, commonly in cooperation with others, has conducted a variety of inventorying, surveying, and monitoring in the NPR-A to better understand the land and its resources. This work includes, but is not limited to, the following:

- **Water Resources and Climate Monitoring:** Water and climatological resources are being monitored and inventoried in the northern NPR-A where oil and gas activities are likely to occur (began 2002; partners include the University of Alaska Fairbanks, National Weather Service, Natural Resources Conservation Service, and U.S. Geological Survey (USGS).
- **Infrastructure Erosion Monitoring:** Coastal erosion is being monitored on BLM-managed lands in arctic Alaska, including the NPR-A (began 1997).
- **Umiat Snow Surveys:** Yearly snow surveys are being conducted near Umiat Airport (began 2008; partners include Natural Resources Conservation Service).
- **Vegetation Monitoring:** Long-term vegetation monitoring is being conducted to measure and record the impacts of, and recovery from, seismic trails and ice roads (began 1999).
- **Post-Fire Tundra Monitoring:** Recovery and potential change is being assessed in plant communities important to arctic and subarctic wildlife following a 2007 late-season severe wildfire and an adjacent, typical, small tundra fire, in light of climate warming and potential increased fire (began 2008, partners include North Slope Borough, University of Alaska-Fairbanks, University of Florida, Forest Service, U.S. Fish and Wildlife Service, and USGS).
- **Eider Surveys:** Spectacled (began 2005) and Steller's (began 2004) eider distribution surveys are being conducted on the Arctic coastal plain in Alaska (partners include North Slope Borough, and U.S. Fish and Wildlife Service.
- **Molting Geese Monitoring Plan:** A plan was developed to monitor molting geese to determine effectiveness of stipulations and permit requirements (plan completed in 2012).
- **Colville River Raptor Surveys:** Surveys are being conducted to contribute to long-term data sets used for permitting and NEPA in the NPR-A (began 1993; partnership with U.S. Fish and Wildlife Service).
- **Alaska Land Bird Monitoring Survey:** Monitoring was initiated to contribute to the statewide knowledge of avian resources, distribution, and abundance in the NPR-A (began 2010; partners include Alaska Bird Observatory, Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, National Park Service, and USGS).

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[1] http://www.northslope.org/

- **Shorebird Monitoring and Surveys:** Monitoring was initiated for potential effects of energy development, human activity, and climate on a suite of breeding shorebirds in NPR-A (began 2010, partners include Wildlife Conservation Society, Manomet Center for Conservation Science, and U.S. Fish and Wildlife Service).
- **Snow Goose Colony Monitoring:** Monitoring was initiated on the occupancy, size, and productivity of the snow goose colony located on the Ikpikpuk River Delta (began 2010; partnership with North Slope Borough).
- **Caribou Monitoring:** Monitoring was initiated for demographics, movements, and seasonal range use of the Teshekpuk and Western Arctic caribou herds in relation to potential oil and gas activities (began 1990; partners include Alaska Department of Fish and Game, Native Villages, National Park Service, North Slope Borough, and U.S. Fish and Wildlife Service).
- **Polar Bear Studies:** Baseline studies were initiated to (1) evaluate terrestrial denning habitats, demographics, summer onshore habitat use, behavior, health, and status of populations; (2) estimate potential impacts of oil and gas development on health and behavior of polar bears; (3) develop a draft mitigation plan to reduce the possibility that industrial activity and changing environmental conditions will interact to the detriment of the polar bear populations; and (4) develop mitigation (began 2009; partners include Bureau of Ocean Energy Management and USGS).
- **Fish Habitat Monitoring:** Monitoring was initiated to assess physical, chemical, and biological characteristics of streams and lakes as related to oil and gas exploration, planned development, and climate change (began 2008; partners include Alaska Department of Fish and Game, University of Alaska-Fairbanks, and USGS).
- **Fish Species Inventory:** Systematic sampling of waterbodies on the Arctic Coastal Plain that were previously unsurveyed to expand knowledge of fish distribution (began 2004; partners include Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, North Slope Borough, University of Alaska-Fairbanks, and USGS).
- **Wilderness Monitoring:** Wilderness inventories were initiated in NPR-A (began 1998).
- **Cultural and Paleontological Monitoring:** Cultural and paleontological resources inventories were initiated to identify, evaluate, and protect resources potentially affected by oil and gas exploration, development, and production activities in the NPR-A (began 1993; past partners have included ConocoPhillips Alaska, Inc.).
- **Surface Inspection and Enforcement Monitoring:** Surface inspection and enforcement monitoring was initiated for oil and gas leasing, right-of-way compliance for oil and gas operations, seismic operations, inspections on legacy wells, and for other mineral actions in support of oil and gas development in the NPR-A (began 1970s).
- **Drilling, Workover, Production, and Abandonment Inspections:** Oil and gas inspections were initiated by certified petroleum engineers or technicians on wells or during the plugging of oil and gas wells, to ensure that equipment, practices, and procedures are in accordance with regulations, orders and any applicable approval documents (began 2000).

In addition, the BLM is currently undertaking a rapid ecological assessment to inform the types of monitoring requirements and mitigation studies that will be necessary for future development.

Monitoring requirements are included in the stipulations and required operating procedures/best management practices identified in Table 2-3. These include:

Subsistence

- Monitoring oil and gas exploration, development, and production effects on subsistence (Required Operating Procedure/Best Management Practice H-1)

Caribou

- Monitoring the movements, distribution, and range use of caribou in areas proposed for development (Stipulation K-5[a] and Stipulation K-12[a])
- Monitoring caribou movements in areas with permanent roads (Stipulation K-5[e] and Stipulation K-12[e])

Birds

- Conducting aerial surveys of Steller's and spectacled eiders, and yellow-billed loons, in areas of facility construction (Required Operating Procedure/Best Management Practice E-11); and
- Monitoring impacts of aircraft and vehicle use and impacts of development within the Goose Molting Area (Stipulation K-4)

Fish

- Monitoring fish-bearing waters when projects impact fish-bearing and non-fish-bearing waterbodies to ensure free passage of fish and water quality (Stipulation E-3)

Bears

- Monitoring bear activity near development and production sites (Required Operating Procedure/Best Management Practice A-8)

Cultural and Paleontological Resources

- Conducting cultural and paleontological surveys in areas where ground-disturbing activities will take place (Required Operating Procedure/Best Management Practice E-13)

In the authorizing/NEPA process for on-the-ground activity or development, the BLM will develop appropriate requirements for the above, as well as additional project-specific monitoring to be carried out as a condition of obtaining subsequent BLM authorizations. Consistent with the provisions of the stipulations and required operating procedures/best management practices, the authorized officer is authorized to approve monitoring plans that combine the efforts of multiple permittees and lessees to meet the obligations of each permittee or lessee. Also note that under Alternative B-2 (section 2.3.2.2), the BLM will implement a management approach that requires industry to fund baseline studies, monitoring, and adaptive management programs.

2.6 Effects on Current and Future Lease Holders

If the BLM in its record of decision for this plan adopts a set of stipulations different from those on existing leases, existing leases may be modified through negotiations with leaseholders to replace the existing lease stipulations. No changes to the stipulations attached to an existing lease would occur until after completion of such negotiations with leaseholders and any additional NEPA review that is determined at that time to be necessary or upon renewal of the lease. In accordance with 43 CFR Part 3135.1-6(c), upon renewal of any lease the stipulations approved in the record of decision for this plan will replace the stipulations attached to the existing lease.

2.7 Healthy Neighbor Policy

The IAP/EIS contains an analysis that addresses potential public health effects of development in the NPR-A. The BLM encourages lessees and permittees engaged in oil and gas exploration, development, and abandonment procedures in the NPR-A to be cognizant of the potential public health impacts of their activities and to work with the local communities to develop and implement measures to avoid, minimize, or mitigate the potential for such impacts. The BLM encourages lessees and permittees to work with the North Slope Borough and communities that could be affected by their activities through preparation of, and regular updates to, a plan for industry and community interaction. The plan should be developed to meet the needs of North Slope communities potentially affected by BLM-authorized activities in the NPR-A, and would be developed in consultation with the communities. See Appendix G of the Northeast NPR-A Supplemental IAP/EIS for examples of elements that may be made part of the plan taken from development experiences elsewhere.

Table 2-3. Alternative stipulations and required operating procedures/best management practices[2]

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
A-1 Required Operating Procedure **Northeast** Objective: Protect the health and safety of oil field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, State, and local law and regulations. Requirement/Standard: Areas of operation shall be left clean of all debris. **Northwest** Objective: Protect the health and safety of oil field workers and the general public by avoiding the disposal of solid waste and garbage near areas of human activity. Requirement/Standard: Same.	***A-1 Best Management Practice*** Objective: Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, State, and local law and regulations. Requirement/Standard: Areas of operation shall be left clean of all debris.			
A-2 Required Operating Procedure **Northeast** Objective: Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations. Requirement/Standard: Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development, including seismic activities. The plan shall be submitted to the authorized officer for approval, in consultation with federal, State, and North Slope Borough regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application.	***A-2 Best Management Practice*** Objective: Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil and gas field workers and the general public. Avoid human-caused changes in predator populations. Requirement/Standard: Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development, including seismic activities. The plan shall be submitted to the authorized officer for approval, in consultation with federal, State, and North Slope Borough regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application.			

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[2] All setback distances in included in this table are to be measured as of the time of the application for a permit for a development. In addition, for Alternatives B-1, B-2, C, and D, facility development along the coast would be required to be designed to maintain the prescribed setback distance for the anticipated life of the facility.

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2 Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>Management decisions affecting waste generation shall be addressed in the following order of priority: (1) prevention and reduction, (2) recycling, (3) treatment, and (4) disposal. The plan shall consider and take into account the following requirements:</td><td colspan="4">Management decisions affecting waste generation shall be addressed in the following order of priority: (1) prevention and reduction, (2) recycling, (3) treatment, and (4) disposal. The plan shall consider and take into account the following requirements:</td></tr>
<tr><td>a. Methods to avoid attracting wildlife to food and garbage. All feasible precautions shall be taken to avoid attracting wildlife to food and garbage. (A list of approved precautions, specific to the type of permitted use, can be obtained from the authorized officer.)</td><td colspan="4">a. Methods to avoid attracting wildlife to food and garbage. The plan shall identify precautions that are to be taken to avoid attracting wildlife to food and garbage.</td></tr>
<tr><td>b. Disposal of putrescible waste. Requirements prohibit the burial of garbage. Lessees and permitted users shall have a written procedure to ensure that the handling and disposal of putrescible waste will be accomplished in a manner that prevents the attraction of wildlife. All putrescible waste shall be incinerated, backhauled, or composted in a manner approved by the authorized officer. All solid waste, including incinerator ash, shall be disposed of in an approved waste-disposal facility in accordance with EPA and Alaska Department of Environmental Conservation regulations and procedures. The burial of human waste is prohibited except as authorized by the authorized officer.</td><td colspan="4">b. Disposal of putrescible waste. Requirements prohibit the burial of garbage. Lessees and permitted users shall have a written procedure to ensure that the handling and disposal of putrescible waste will be accomplished in a manner that prevents the attraction of wildlife. All putrescible waste shall be incinerated, backhauled, or composted in a manner approved by the authorized officer. All solid waste, including incinerator ash, shall be disposed of in an approved waste-disposal facility in accordance with EPA and Alaska Department of Environmental Conservation regulations and procedures. The burial of human waste is prohibited except as authorized by the authorized officer.</td></tr>
<tr><td>c. Disposal of pumpable waste products. Except as specifically provided, the BLM requires that all pumpable solid, liquid, and sludge waste be disposed of by injection in accordance with EPA, Alaska Department of Environmental Conservation, and the Alaska Oil and Gas Conservation Commission regulations and procedures. On-pad temporary muds and cuttings storage, as approved by Alaska Department of Environmental Conservation, will be allowed as necessary to facilitate annular injection and/or backhaul operations.</td><td colspan="4">c. Disposal of pumpable waste products. Except as specifically provided, the BLM requires that all pumpable solid, liquid, and sludge waste be disposed of by injection in accordance with EPA, Alaska Department of Environmental Conservation, and the Alaska Oil and Gas Conservation Commission regulations and procedures. On-pad temporary muds and cuttings storage, as approved by Alaska Department of Environmental Conservation, will be allowed as necessary to facilitate annular injection and/or backhaul operations.</td></tr>
<tr><td>d. Disposal of wastewater and domestic wastewater. The BLM prohibits wastewater discharges or disposal of domestic wastewater into bodies of fresh, estuarine, and marine water, including wetlands, unless authorized by a National Pollutant Discharge Elimination System or State permit.</td><td colspan="4">d. Disposal of wastewater and domestic wastewater. The BLM prohibits wastewater discharges or disposal of domestic wastewater into bodies of fresh, estuarine, and marine water, including wetlands, unless authorized by a National Pollutant Discharge Elimination System or State permit.</td></tr>
<tr><td>Northwest
<u>Objective</u>: Same
<u>Requirement/Standard</u>: Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development, including seismic activities. Management decisions affecting waste generation shall be addressed in the following order of priority: (1) prevention and</td><td colspan="4"></td></tr>
</table>

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
reduction, (2) recycling, (3) treatment, and (4) disposal. The plan shall be submitted to the authorized officer for approval, in consultation with federal, State, and North Slope Borough regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application. The plan shall consider and take into account the following requirements: [Requirements a through d are the same as in Northeast.]				
A-3 Required Operating Procedure **Northeast** Objective: Minimize pollution through effective hazardous-materials contingency planning. Requirement/Standard: For oil- and gas-related activities, a hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures applicable to fuel and hazardous substances handling (associated with transportation vehicles) shall consist of best management practices if approved by the authorized officer. The plan shall include a list of resources available for response (e.g., heavy-equipment operators, spill-cleanup materials, or companies), and names and phone numbers of federal, State, and North Slope Borough contacts. Other federal and State regulations may apply and require additional planning requirements. All appropriate staff shall be instructed regarding these procedures. In addition contingency plans related to facilities developed for oil production shall include requirements to: a. Provide refresher spill-response training to North Slope Borough and local community spill-response teams on a yearly basis. b. Plan and conduct a major spill-response field-deployment drill annually. c. Prior to production and as required by law, develop spill prevention and response contingency plans and participate in development and maintenance of the North Slope Subarea Contingency Plan for Oil and Hazardous Substances Discharges/Releases for the National Petroleum Reserve-Alaska operating area. Planning shall include development	***A-3 Best Management Practice*** Objective: Minimize pollution through effective hazardous-materials contingency planning. Requirement/Standard: For oil- and gas-related activities, a hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures in the plan applicable to fuel and hazardous substances handling (associated with transportation vehicles) shall consist of best management practices if approved by the authorized officer. The plan shall include a list of resources available for response (e.g., heavy-equipment operators, spill-cleanup materials or companies), and names and phone numbers of federal, State, and North Slope Borough contacts. Other federal and State regulations may apply and require additional planning requirements. All appropriate staff shall be instructed regarding these procedures. In addition contingency plans related to facilities developed for oil production shall include requirements to: a. Provide refresher spill-response training to North Slope Borough and local community spill-response teams on a yearly basis. b. Plan and conduct a major spill-response field-deployment drill annually. c. Prior to production and as required by law, develop spill prevention and response contingency plans and participate in development and maintenance of the North Slope Subarea Contingency Plan for Oil and Hazardous Substances Discharges/Releases for the National Petroleum Reserve-Alaska operating area. Planning shall include development and funding of detailed (e.g., 1:26,000 scale) environmental sensitivity index maps for the lessee's/permittee's operating area and areas outside the lessee's/permittee's operating area that could be affected by their activities. (The specific area to be			

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
and funding of detailed (e.g., 1:26,000 scale) environmental sensitivity index maps for the lessee's operating area and areas outside the lessee's operating area that could be affected by their activities. (The specific area to be mapped shall be defined in the lease agreement and approved by the authorized officer in consultation with appropriate resource agencies.) Maps shall be completed in paper copy and geographic information system format in conformance with the latest version of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration's Environmental Sensitivity Index Guidelines. Draft and final products shall be peer reviewed and approved by the authorized officer in consultation with appropriate federal, State, and North Slope Borough resource and regulatory agencies. **Northwest** Objective: Same Requirement/Standard: For oil- and gas-related activities, a hazardous-materials emergency-contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures applicable to fuel and hazardous substances handling (associated with transportation vehicles) may consist of best management practices if approved by the authorized officer. The plan shall include a list of resources available for response (e.g., heavy-equipment operators, spill-cleanup materials or companies), and names and phone numbers of federal, State, and North Slope Borough contacts. Other federal and State regulations may apply and require additional planning requirements. All staff shall be instructed regarding these procedures.	mapped shall be defined in the lease agreement and approved by the authorized officer in consultation with appropriate resource agencies.) Maps shall be completed in paper copy and geographic information system format in conformance with the latest version of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration's Environmental Sensitivity Index Guidelines. Draft and final products shall be peer reviewed and approved by the authorized officer in consultation with appropriate federal, State, and North Slope Borough resource and regulatory agencies.			

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td><i>A-4 Required Operating Procedure</i>
Northeast
<u>Objective</u>: Minimize the impact of contaminants on fish, wildlife, and the environment; including wetlands, marshes and marine waters; as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.
<u>Requirement/Standard</u>: Before initiating any oil and gas or related activity or operation, including field research/surveys and/or seismic operations, lessees/permittees shall develop a comprehensive spill prevention and response contingency plan per 40 CFR § 112 (Oil Pollution Act). The plan shall consider and take into account the following requirements:
a. <u>On-site Clean-up Materials</u>. Sufficient oil-spill-cleanup materials (absorbents, containment devices, etc.) shall be stored at all fueling points and vehicle-maintenance areas and shall be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment.
b. <u>Storage Containers</u>. Fuel and other petroleum products and other liquid chemicals shall be stored in proper containers at approved locations. Except during overland moves and seismic operations, fuel, other petroleum products, and other liquid chemicals designated by the authorized officer that in total exceed 1,320 gallons shall be stored within an impermeable lined and diked area or within approved alternate storage containers, such as over packs, capable of containing 110% of the stored volume. In areas within 500 feet of waterbodies, fuel containers are to be stored within appropriate containment.
c. <u>Liner Materials</u>. Liner material shall be compatible with the stored product and capable of remaining impermeable during typical weather extremes expected throughout the storage period.
d. <u>Permanent Fueling Stations</u>. Permanent fueling stations shall be lined or have impermeable protection to prevent fuel migration to the environment from overfills and spills.
e. <u>Proper Identification of Containers</u>. All fuel containers, including barrels and propane tanks, shall be marked with the responsible party's name, product type, and year filled or purchased.</td><td colspan="4"><i>A-4 Best Management Practice</i>
<u>Objective</u>: Minimize the impact of contaminants on fish, wildlife, and the environment; including wetlands, marshes and marine waters; as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.
<u>Requirement/Standard</u>: Before initiating any oil and gas or related activity or operation, including field research/surveys and/or seismic operations, lessees/permittees shall develop a comprehensive spill prevention and response contingency plan per 40 CFR § 112 (Oil Pollution Act). The plan shall consider and take into account the following requirements:
a. <u>On-site Clean-up Materials</u>. Sufficient oil-spill-cleanup materials (absorbents, containment devices, etc.) shall be stored at all fueling points and vehicle-maintenance areas and shall be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment.
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WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

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<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>f. Notice of Reportable Spills. Notice of any reportable spill (as required by 40 CFR § 300.125 and 18 AAC § 75.300) shall be given to the authorized officer as soon as possible, but no later than 24 hours after occurrence.
g. Identification of Oil Pans <i>("duck ponds")</i>. All oil pans shall be marked with the responsible party's name.
Northwest
Objective: Minimize the impact of contaminants on fish, wildlife, and the environment; including wetlands, marshes and marine waters; as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and activities. Protect public health and safety.
Requirement/Standard: Before initiating any oil and gas or related activity or operation, including field research/surveys and/or seismic operations, lessees/permittees shall develop a comprehensive spill prevention and response contingency plan per 40 CFR 112 (OPA). The plan shall consider and take into account the following requirements:
a. On-site clean-up materials. Sufficient oil-spill-cleanup materials (absorbents, containment devices, etc.) shall be stored at all fueling points and vehicle-maintenance areas and shall be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment.
b. Storage Containers. Fuel and other petroleum products and other liquid chemicals shall be stored in proper containers at approved locations. Except during overland moves and seismic operations, fuel, other petroleum products, and other liquid chemicals designated by the authorized officer in excess of 1,320 gallons in storage capacity, shall be stored within an impermeable lined and diked area or within approved alternate storage containers such as overpacks, capable of containing 110% of the stored volume.
<i>[Requirements c through f are the same as in Northeast.]</i></td><td colspan="4">f. Notice of Reportable Spills. Notice of any reportable spill (as required by 40 CFR § 300.125 and 18 AAC § 75.300) shall be given to the authorized officer as soon as possible, but no later than 24 hours after occurrence.
g. Identification of Oil Pans <i>("duck ponds")</i>. All oil pans shall be marked with the responsible party's name.
<i>(Text is same as in Northeast NPR-A 2008 Record of Decision)</i></td></tr>
</table>

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
A-5 Required Operating Procedure **Northeast** Objective: Minimize the impact of contaminants from refueling operations on fish, wildlife and the environment. Requirement/Standard: Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any water body with the exception of small caches (up to 210 gallons) for motor boats, float planes, ski planes, and small equipment, e.g., portable generators and water pumps, will be permitted. The authorized officer may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions. **Northwest** Objective: Minimize the impact of contaminants from refueling operations on fish, wildlife and the environment. Requirement/Standard: Refueling of equipment within 500 feet of the active floodplain of any fish-bearing water body and 100 feet of non-fish-bearing waterbodies is prohibited. Small caches (up to 210 gallons) for motorboats, float planes, ski planes, and small equipment, e.g., portable generators and water pumps, will be permitted. The authorized officer may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions.	***A-5 Best Management Practice*** Objective: Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment. Requirement/Standard: Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any water body with the exception of small caches (up to 210 gallons) for motor boats, float planes, ski planes, and small equipment, e.g., portable generators and water pumps, will be permitted. The authorized officer may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			
A-6 Required Operating Procedure **Northeast** Objective: Minimize the impact on fish, wildlife, and the environment from contaminants associated with the exploratory drilling process. Requirement/Standard: Surface discharge of reserve-pit fluids is prohibited. **Northwest** Objective: Same. Requirement/Standard: Surface discharge of reserve-pit fluids is prohibited unless authorized by applicable National Pollutant Discharge Elimination System, Alaska Department of Environmental Conservation, and North Slope Borough permits (as appropriate) and approved by the authorized officer.	***A-6 Best Management Practice*** Objective: Minimize the impact on fish, wildlife, and the environment from contaminants associated with the exploratory drilling process. Requirement/Standard: Surface discharge of reserve-pit fluids is prohibited. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
A-7 Required Operating Procedure **Northeast** Objective: Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment. Requirement/Standard: Discharge of produced water in upland areas and marine waters is prohibited. **Northwest** Objective: Same. Requirement/Standard: Procedures for the disposal of produced fluids shall meet the following: a. In upland areas, including wetlands, disposal will be by subsurface-disposal techniques. The authorized officer may permit alternate disposal methods if the lessee demonstrates that subsurface disposal is not feasible or prudent and the alternative method will not result in adverse environmental effects. b. In marine waters, approval of discharges by the authorized officer will be based on a case-by-case review of environmental factors and consistency with the conditions of a National Pollutant Discharge Elimination System permit. Discharge of produced fluids will be prohibited at locations where currents and water depths, in combination with other conditions, are not adequate to prevent impacts to known biologically sensitive areas. Alternate disposal methods will require an National Pollutant Discharge Elimination System permit certified by the State.	***A-7 Best Management Practice*** Objective: Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment. Requirement/Standard: Discharge of produced water in upland areas and marine waters is prohibited. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			
A-8 Required Operating Procedure **Northeast** Objective: Minimize conflicts resulting from interaction between humans and bears during oil and gas activities. Requirement/Standard: Oil and gas lessees and their contractors and subcontractors will, as a part of preparation of lease operation planning, prepare and implement bear-interaction plans to minimize conflicts between bears and humans. These plans shall include measures to: a. Minimize attraction of bears to the drill sites. b. Organize layout of buildings and work areas to minimize human/bear interactions. c. Warn personnel of bears near or on drill sites and identify proper procedures to be followed.	***A-8 Best Management Practice*** Objective: Minimize conflicts resulting from interaction between humans and bears during oil and gas activities. Requirement/Standard: Oil and gas lessees and their contractors and subcontractors will, as a part of preparation of lease operation planning, prepare and implement bear-interaction plans to minimize conflicts between bears and humans. These plans shall include measures to: a. Minimize attraction of bears to the work sites. b. Organize layout of buildings and work sites to minimize human/bear interactions. c. Warn personnel of bears near or on work sites and identify proper procedures to be followed.			

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
d. Establish procedures, if authorized, to discourage bears from approaching the drill site. e. Provide contingencies in the event bears do not leave the site or cannot be discouraged by authorized personnel. f. Discuss proper storage and disposal of materials that may be toxic to bears. g. Provide a systematic record of bears on the site and in the immediate area. h. Encourage lessee/permittee to participate and comply with the Incidental Take Program under the Marine Mammal Protection Act.[3] **Northwest** Objective: Minimize conflicts resulting from interaction between humans and bears during leasing and associated activities. Requirement/Standard: Same, except lacks subpart h.	d. Establish procedures, if authorized, to discourage bears from approaching the work site. e. Provide contingencies in the event bears do not leave the work site or cannot be discouraged by authorized personnel. f. Discuss proper storage and disposal of materials that may be toxic to bears. g. Provide a systematic record of bears on the work site and in the immediate area.			
A-9 Required Operating Procedure **Northeast** Objective: Reduce air quality impacts. Requirement/Standard: Concurrent with implementation of the requirement for adoption of use of ultra low sulfur diesel in the "North Slope Ultra Low Sulfur Diesel Transition Agreement," as amended, between the State of Alaska, BP Exploration (Alaska) Inc. and ConocoPhillips Alaska, Inc., or implementation of federal regulations requiring use of "ultra low sulfur" diesel within NPR-A if these regulations take effect prior to the transition agreement, all oil and gas operations (vehicles and equipment) that burn diesel fuels must use "ultra low sulfur" diesel as defined by the Alaska Department of Environmental Conservation-Division of Air Quality, subject to its availability. The use of alternative diesel fuel may be considered and approved by BLM's authorized officer on a case-by-case basis. **Northwest** No comparable provision.	***A-9 Best Management Practice*** Objective: Reduce air quality impacts. Requirement/Standard: All oil and gas operations (vehicles and equipment) that burn diesel fuels must use "ultra-low sulfur" diesel as defined by the Alaska Department of Environmental Conservation-Division of Air Quality.			

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[3] An analogous subparagraph A-8h is not included in Alternatives B through D. The polar bear is now provided protection under both the MMPA and the ESA.

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
A-10 Required Operating Procedure **Northeast** Objective: Prevent unnecessary or undue degradation of the lands and protect health. Requirement/Standard: This measure includes the following elements: a. Prior to initiation of a NEPA analysis for an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the lessee shall obtain on-site background air quality and meteorology data to be used in predicting potential future air quality conditions resulting from the proposed action and other reasonably foreseeable future actions. Monitoring should examine the background concentration of criteria air pollutants. Monitoring data collection must meet BLM standards for quality control and quality assurance before use. (The BLM may consult with the applicant and appropriate federal, State, and/or local agencies to avoid duplication of effort.) The monitoring mechanism for the predevelopment stage would be one that does not require an on-site air polluting emission source. If background data exists that the authorized officer determines is representative of that existing at the proposed development site, the authorized officer may waive this requirement. b. For developments with a potential for air pollutant emissions as described in subparagraph (a), the lessee shall prepare (and submit for BLM approval) a complete list of reasonably foreseeable air pollutant emissions, including, but not limited to criteria air pollutants and hazardous air pollutants designated under authority of the Clean Air Act, as amended. c. For developments with a potential for air pollutant emissions as described in subparagraph (a) and informed by the pollutant emissions identified in subparagraph (b), the authorized officer may require air quality modeling using BLM-approved atmospheric dispersion models that are appropriate for local conditions. (The authorized officer may consult with the applicant and appropriate federal, State, and/or local agencies regarding modeling to inform his/her decision and avoid duplication of effort.) The modeling shall compare predicted impacts to all applicable local, State, and federal air quality standards and increments, as well as other scientifically defensible significance thresholds (such as impacts to air quality related values, incremental cancer risks, etc.).	***A-10 Best Management Practice*** Objective: Prevent unnecessary or undue degradation of the lands and protect health. Requirement/Standard: This measure includes the following elements: a. Prior to initiation of a NEPA analysis for an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source (hereafter project), the authorizing officer (BLM) may require the project proponent to provide a minimum of one year of baseline ambient air monitoring data for any pollutant(s) of concern as determined by BLM if no representative air monitoring data are available for the project area, or existing representative ambient air monitoring data are insufficient, incomplete, or do not meet minimum air monitoring standards set by the Alaska DEC or the EPA. If BLM determines that baseline monitoring is required, this pre-analysis data must meet Alaska DEC and EPA air monitoring standards, and cover the year immediately prior to the submittal. Pre-project monitoring may not be appropriate where the life of the project is less than one year. b. The BLM may require monitoring for the life of the project depending on the magnitude of potential air emissions from the project, proximity to a federally mandated Class I area, sensitive Class II area (as identified on a case-by-case basis by Alaska DEC or a federal land management agency), or population center, location within or proximity to a non-attainment or maintenance area, meteorological or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during NEPA undertaken for the project. c. For an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the project proponent shall prepare (and submit for BLM approval) an emissions inventory that includes quantified emissions of regulated air pollutants from all direct and indirect sources related to the proposed project, including reasonably foreseeable air pollutant emissions of criteria air pollutants, volatile organic compounds, hazardous air pollutants, and greenhouse gases estimated for each year for the life of the project. The BLM will use this estimated emissions inventory to identify pollutants of concern and to determine the appropriate level of air analysis to be conducted for the proposed project.			

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>d. Depending on the significance of the predicted impacts, a lessee proposing a central production facility or other facility with potentially significant impacts on air quality may be required to monitor air pollutant emissions and/or air quality impacts for at least one year of operation. Depending upon the initial monitoring results, the authorized officer may require additional monitoring.
e. If monitoring indicates impacts would cause unnecessary or un-due degradation of the lands or fail to protect health (either directly or through use of subsistence resources), the authorized officer may require changes in the lessee's activities at any time to reduce these emissions, such as, but not limited to, use of cleaner-burning fuels or installation of additional emission control systems.
Northwest
No comparable provision.</td><td colspan="4">d. For an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the BLM may require the proponent to provide an emissions reduction plan that includes a detailed description of operator committed measures to reduce project related air pollutant emissions including, but not limited to greenhouse gases and fugitive dust.
e. For an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the authorized officer may require air quality modeling for purposes of analyzing project direct, indirect or cumulative impacts to air quality. The BLM may require air quality modeling depending on the magnitude of potential air emissions from the project or activity, duration of the proposed action, proximity to a federally mandated Class I area, sensitive Class II area (as identified on a case-by-case basis by Alaska DEC or a federal land management agency), or population center, location within a non-attainment or maintenance area, meteorological or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during NEPA undertaken for the project. The BLM will determine the information required for a project specific modeling analysis through the development of a modeling protocol for each analysis. The authorized officer will consult with appropriate federal, State, and/or local agencies regarding modeling to inform his/her modeling decision and avoid duplication of effort. The modeling shall compare predicted impacts to all applicable local, State, and federal air quality standards and increments, as well as other scientifically defensible significance thresholds (such as impacts to air quality related values, incremental cancer risks, etc.).
f. The BLM may require air quality mitigation measures and strategies within its authority (and in consultation with local, state, federal, and tribal agencies with responsibility for managing air resources) in addition to regulatory requirements and proponent committed emission reduction measures, and for emission sources not otherwise regulated by Alaska DEC or EPA, if the air quality analysis shows potential future impacts to NAAQS or AAAQS or impacts above specific levels of concern for air quality related values (AQRVs).
g. If ambient air monitoring indicates that project-related emissions are causing or contributing to impacts that would cause unnecessary or undue degradation of the lands, cause exceedances of NAAQS, or fail to protect health (either directly or through use of subsistence resources), the authorized officer may require changes in activities at any time to reduce these emissions to comply with the NAAQS and/or minimize impacts to AQRVs. Within the scope of BLM's authority, the BLM may require additional emission control strategies to minimize or reduce impacts to air quality.
h. (Alternative B-2 only) Publicly available reports on air quality baseline monitoring, emissions inventory, and modeling results developed in conformance with this best management procedure shall be provided by the project proponent to the North Slope Borough and to local communities and tribes in a timely manner.</td></tr>
</table>

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
A-11 Required Operating Procedure **Northeast** Objective: Ensure that permitted activities do not create human health risks through contamination of subsistence foods. Requirement/Standard: A lessee proposing a permanent oil and gas development shall design and implement a monitoring study of contaminants in locally-used subsistence foods. The monitoring study shall examine subsistence foods for all contaminants that could be associated with the proposed development. The study shall identify the level of contaminants in subsistence foods prior to the proposed permanent oil and gas development and monitor the level of these contaminants throughout the operation and abandonment phases of the development. If ongoing monitoring detects a measurable and persistent increase in a contaminant in subsistence foods, the lessee shall design and implement a study to determine how much, if any, of the increase in the contaminant in subsistence foods originates from the lessee's activities. If the study determines that a portion of the increase in contamination in subsistence foods is caused by the lessee's activities, the authorized officer may require changes in the lessee's processes to reduce or eliminate emissions of the contaminant. The design of the study/studies must meet the approval of the authorized officer. The authorized officer may consult with appropriate federal, State, and North Slope Borough agencies prior to approving the study/studies design. The authorized officer may require/authorize changes in the design of the studies throughout the operations and abandonment period, or terminate or suspend studies if results warrant. **Northwest** No comparable provision.	***A-11 Best Management Practice*** Objective: Ensure that permitted activities do not create human health risks through contamination of subsistence foods. Requirement/Standard: A lessee proposing a permanent oil and gas development shall design and implement a monitoring study of contaminants in locally-used subsistence foods. The monitoring study shall examine subsistence foods for all contaminants that could be associated with the proposed development. The study shall identify the level of contaminants in subsistence foods prior to the proposed permanent oil and gas development and monitor the level of these contaminants throughout the operation and abandonment phases of the development. If ongoing monitoring detects a measurable and persistent increase in a contaminant in subsistence foods, the lessee shall design and implement a study to determine how much, if any, of the increase in the contaminant in subsistence foods originates from the lessee's activities. If the study determines that a portion of the increase in contamination in subsistence foods is caused by the lessee's activities, the authorized officer may require changes in the lessee's processes to reduce or eliminate emissions of the contaminant. The design of the study/studies must meet the approval of the authorized officer. The authorized officer may consult with appropriate federal, State, and North Slope Borough agencies prior to approving the study/studies design. The authorized officer may require/authorize changes in the design of the studies throughout the operations and abandonment period, or terminate or suspend studies if results warrant. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
No comparable provision.	*A-12 Best Management Practice* **NOTE: This best management practice is applicable only to Alternative B-2**. There would be no comparable provision for any of the other alternatives. Objective: To minimize negative health impacts associated with oil spills. Requirement/Standard: If an oil spill with potential impacts to public health occurs, the BLM, in undertaking its oil spill responsibilities, will consider: a. Immediate health impacts and responses for affected communities and individuals. b. Long-term monitoring for contamination of subsistence food sources. c. Long-term monitoring of potential human health impacts. d. Perceptions of contamination and subsequent changes in consumption patterns. e. Health promotion activities and communication strategies to maintain the consumption of traditional food.			

WATER USE FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
B-1 Required Operating Procedure **Northeast** Objective: Maintain populations of, and adequate habitat for, fish and invertebrates. Requirement/Standard: Water withdrawal from rivers and streams during winter is prohibited. **Northwest** Same	*B-1 Best Management Practice* Objective: Maintain populations of, and adequate habitat for, fish and invertebrates. Requirement/Standard: Withdrawal of unfrozen water from rivers and streams during winter is prohibited. The removal of ice aggregate from grounded areas ≤4-feet deep may be authorized from rivers on a site-specific basis.			
B-2 Required Operating Procedure Objective: Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish and invertebrates, and waterfowl. Requirement/Standard: Water withdrawal from lakes may be authorized on a site-specific basis depending on water volume and depth, and fish population and species diversification. Current water withdrawal requirements specify: a. Lakes that are ≥7 feet with sensitive fish (any fish except ninespine stickleback or Alaska blackfish), water available for withdrawal is limited to 15% of calculated volume deeper than 7 feet; lakes that are between 5 and 7 feet with sensitive fish,	*B-2 Best Management Practice* Objective: Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl. Requirement/Standard: Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas ≤4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community. Current water use requirements are: a. Lakes with sensitive fish (i.e., any fish except ninespine stickleback or Alaska blackfish): unfrozen water available for withdrawal is limited to 15% of calculated volume deeper than 7 feet; only ice aggregate may be removed from lakes that are ≤7-feet deep.			

WATER USE FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
water available for withdrawal would be calculated on a case-by-case basis. b. Lakes that are ≥5feet with only non-sensitive fish (i.e., ninespine stickleback or Alaska blackfish), water available for withdrawal is limited to 30% of calculated volume deeper than 5 feet. c. Any lake with no fish present, regardless of depth, water available for withdrawal is up to 35% as specified within the permit. d. A water-monitoring plan may be required to assess drawdown and water quality changes before, during, and after pumping any fish-bearing lake or lake of special concern. e. The removal of naturally grounded ice may be authorized from lakes and shallow rivers on a site-specific basis depending upon its size, water volume, and depth, and fish population and species diversification. f. Removed ice aggregate shall be included in the 15% or 30% withdrawal limits—whichever is appropriate—unless otherwise approved. g. Any water intake structures in fish bearing or non-fish bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. **Note**: All water withdrawal equipment must be equipped and must utilize fish screening devices approved by the Alaska Department of Natural Resources. [**Note:** Responsibility in the State for such approval now rests with the Alaska Department of Fish and Game, Division of Habitat.] h. Compaction of snow cover or snow removal from fish-bearing waterbodies shall be prohibited except at approved ice road crossings, water pumping stations on lakes, or areas of grounded ice. **Northwest** Objective: Maintain natural hydrologic regimes in soils surrounding lakes and ponds and maintain populations of, and adequate habitat for, fish and invertebrates. Requirement/Standard: Water withdrawal from lakes may be authorized on a site-specific basis depending on size, water volume, and depth, and fish population and species diversification. Current water withdrawal requirements specify: a. Water withdrawals from any fish bearing lake 7 feet or deeper shall be limited to 15 percent of the estimated free	b. Lakes with only non-sensitive fish (i.e., ninespine stickleback or Alaska blackfish): unfrozen water available for withdrawal is limited to 30% of calculated volume deeper than 5 feet; only ice aggregate may be removed from lakes that are ≤5. c. Lakes with no fish present, regardless of depth: water available for use is limited to 35% of total lake volume. d. In lakes where unfrozen water and ice aggregate are both removed, the total use shall not exceed the respective 15%, 30%, or 35% volume calculations. e. Additional modeling or monitoring may be required to assess water level and water quality conditions before, during, and after water use from any fish-bearing lake or lake of special concern. f. Any water intake structures in fish bearing or non-fish bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. **Note**: All water withdrawal equipment must be equipped and must utilize fish screening devices approved by the Alaska Department of Fish and Game, Division of Habitat. g. Compaction of snow cover or snow removal from fish-bearing waterbodies shall be prohibited except at approved ice road crossings, water pumping stations on lakes, or areas of grounded ice.			

WATER USE FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
water volume located beneath the ice. b. Water withdrawals from lakes with depths between 5 and 7 feet that contain only ninespine stickleback and/or Alaska blackfish are limited to up to 30 percent of the under-ice volume. c. Water withdrawal may be authorized from any lake if the proponent demonstrates that no fish exist in the lake. d. A water-monitoring plan may be required to assess drawdown and water quality changes before, during, and after pumping any fish-bearing lake. e. Same. f. Same. g. Any water intake structures in fish-bearing waters shall be designed, operated and maintained to prevent fish entrapment, entrainment, or injury. h. Same.				

WINTER OVERLAND MOVES AND SEISMIC WORK

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
The following required operating procedures/best management practices apply to overland moves, seismic work, and any similar cross-country vehicle use of heavy equipment on non-roaded surfaces during the winter season. These restrictions do not apply to the use of such equipment on ice roads after they are constructed.				
C-1 Required Operating Procedure **Northeast** Objective: Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations. Requirement/Standard: a. Cross-country use of heavy equipment and seismic activities is prohibited within 0.5 mile of occupied grizzly bear dens identified by the Alaska Department of Fish and Game unless alternative protective measures are approved by the authorized officer in consultation with the Alaska Department of Fish and Game. b. Cross-country use of heavy equipment and seismic activities is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. Operators shall consult with the USFWS and/or NOAA Fisheries, as appropriate, before initiating activities in coastal habitat between October 30 and April 15. **Northwest** Same.	***C-1 Best Management Practice*** Objective: Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations. Requirement/Standard: a. Cross-country use of heavy equipment and seismic activity is prohibited within 0.5 mile of occupied grizzly bear dens identified by the Alaska Department of Fish and Game unless alternative protective measures are approved by the authorized officer in consultation with the Alaska Department of Fish and Game. b. Cross-country use of heavy equipment and seismic activity is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. Operators near coastal areas shall conduct a survey for potential polar bear dens and seal birthing lairs and consult with the USFWS and/or NOAA Fisheries, as appropriate, before initiating activities in coastal habitat between October 30 and April 15. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

WINTER OVERLAND MOVES AND SEISMIC WORK

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td><i>C-2 Required Operating Procedure</i>
Northeast
Objective: Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.
Requirement/Standard:
a. Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Ground operations shall cease when the spring snowmelt begins (approximately May 5 in the foothills area where elevations reach or exceed 500 feet and approximately May 15 in the northern coastal areas). The exact dates will be determined by the authorized officer.
b. Only low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. A list of approved vehicles can be obtained from the authorized officer. Limited use of tractors equipped with wide tracks or “shoes” will be allowed to pull trailers, sleighs or other equipment with approved undercarriage. Note: This provision does not include the use of heavy equipment such as front-end loaders and similar equipment required during ice road construction.
c. Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited; however, on existing trails, seismic lines or camps, clearing of drifted snow is allowed to the extent that the tundra mat is not disturbed.
d. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips unless necessitated by serious safety or superseding environmental concern. This provision does not apply to hardened snow trails for use by low-ground-pressure vehicles such as Rolligons.
e. The location of winter ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year.
f. Motorized ground-vehicle use within the Colville River Special Area associated with overland moves, seismic work, and any similar use of heavy equipment shall be minimized within the Colville River Raptor, Passerine, and Moose Area from April 15 through August 5, with the exception that use will be minimized in the vicinity of gyrfalcon nests beginning March 15. Such use will remain 0.5 mile away from known</td><td colspan="4"><i>C-2 Best Management Practice</i>
Objective: Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.
Requirement/Standard:
a. Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Ground operations shall cease when the spring snowmelt begins (approximately May 5 in the foothills area where elevations reach or exceed 500 feet and approximately May 15 in the northern coastal areas). The exact dates will be determined by the authorized officer.
b. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Low-ground-pressure vehicles shall be selected and operated in a manner that eliminates direct impacts to the tundra by shearing, scraping, or excessively compacting the tundra mat. Note: This provision does not include the use of heavy equipment such as front-end loaders and similar equipment required during ice road construction.
c. Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited; however, on existing trails, seismic lines or camps, clearing of drifted snow is allowed to the extent that the tundra mat is not disturbed.
d. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips unless necessitated by serious safety or superseding environmental concern. This provision does not apply to hardened snow trails for use by low-ground-pressure vehicles such as Rolligons.
e. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year.
f. Motorized ground-vehicle use within the Colville River Special Area associated with overland moves, seismic work, and any similar use of heavy equipment shall be minimized within an area that extends 1 mile west or northwest of the bluffs of the Colville River, and 2 miles on either side of the Kogosukruk and Kikiakrorak rivers and tributaries of the Kogosukruk River from April 15 through August 5, with the exception that use will be minimized in the vicinity of gyrfalcon nests beginning March 15. Such use will remain 0.5 mile away from known raptor nesting sites, unless authorized by the authorized officer.</td></tr>
</table>

WINTER OVERLAND MOVES AND SEISMIC WORK

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
raptor nesting sites, unless authorized by the authorized officer. [The Colville River Raptor, Passerine, and Moose Area extends 1 mile west or northwest of the bluffs of the Colville River, from approximately Ocean Point to the southern end of the Northeast NPR-A planning area and 2 miles on either side of the Kogosukruk and Kikiakrorak rivers and tributaries of the Kogosukruk River.] **Northwest** Same, except lacks subpart f. **Colville River Special Area Management Plan Protection 7** Objective: Minimize disturbance impacts to nesting arctic peregrine falcons in the Colville River Special Area from motorized ground-vehicle use. Requirement/Standard Motorized ground-vehicle use within the Colville River Special Area authorized by BLM shall be minimized within 1 mile of any known arctic peregrine falcon nest from April 15 through August 15. Such use shall be prohibited within 0.5 mile of nests during the same period unless an exception is granted by BLM.	*(Colville River Special Area Management Plan Protection 7 would not be changed.)*			
C-3 Required Operating Procedure **Northeast** Objective: Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality and protect stream banks. Requirement/Standard: Crossing of waterway courses shall be made using a low-angle approach. Snow and ice bridges shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris. Except at approved crossings, operators are encouraged to travel a minimum of 100 feet from known overwintering fish streams and lakes. **Northwest** Objective: Maintain natural spring runoff patterns, avoid flooding, prevent streambed sedimentation, protect water quality and protect stream banks. Requirement/Standard: Crossing of waterway courses shall be made using a low-angle approach. Snow and ice bridges shall be removed, breached or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.	***C-3 Best Management Practice*** Objective: Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality and protect stream banks. Requirement/Standard: Crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.			

WINTER OVERLAND MOVES AND SEISMIC WORK

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td><i>C-4 Required Operating Procedure</i>
Northeast
<u>Objective</u>: Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.
<u>Requirement/Standard</u>: Travel up and down streambeds is prohibited unless it can be demonstrated that there will be no additional impacts from such travel to over-wintering fish or the invertebrates they rely on. Rivers and streams shall be crossed at shallow riffles from point bar to point bar whenever possible.
Northwest
<u>Objective</u>:
Same
<u>Requirement/Standard</u>: Travel up and down streambeds is prohibited. Rivers and streams shall be crossed at shallow riffles from point bar to point bar whenever possible.</td><td colspan="4"><i>C-4 Best Management Practice</i>
<u>Objective</u>: Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.
<u>Requirement/Standard</u>: Travel up and down streambeds is prohibited unless it can be demonstrated that there will be no additional impacts from such travel to over-wintering fish or the invertebrates they rely on. Rivers, streams, and lakes shall be crossed at areas of grounded ice whenever possible.</td></tr>
<tr><td>No comparable provision.</td><td colspan="4"><i>C-5 Best Management Practice</i>
NOTE: This best management practice is only applicable to Alternative B-2. There would be no comparable provision for any of the other alternatives.
<u>Objective</u>: Minimize the effects of high-intensity acoustic energy from seismic surveys on fish..
<u>Requirement/Standard</u>:
a. When conducting vibroseis-based surveys above potential fish overwintering areas (water 6 feet deep or greater, ice plus liquid depth), operators shall follow recommendations by Morris and Winters (2005): only a single set of vibroseis shots should be conducted if possible; if multiple shot locations are required, these should be conducted with minimal delay; multiple days of vibroseis activity above the same overwintering area should be avoided if possible.
b. When conducting air gun-based surveys in freshwater, operators shall follow standard marine mitigation measures that are applicable to fish (e.g., Minerals Management Service 2006): operators will use the lowest sound levels feasible to accomplish their data-collection needs; ramp-up techniques will be utilized (ramp-up involves the gradual increase in emitted sound levels beginning with firing a single air gun and gradually adding air guns until the desired operating level of the full array is obtained).
c. When conducting explosive-based surveys, operators shall follow setback distances from fish-bearing waterbodies based on requirements outlined by Alaska Department of Fish and Game (1991).</td></tr>
</table>

OIL AND GAS EXPLORATORY DRILLING

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
D-1 Lease Stipulation **Northeast** Objectives: Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat. Requirement/Standard: Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes. **Northwest** Objectives: Same. Requirement/Standard: Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes, except where the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative.	***D-1 Lease Stipulation*** Objectives: Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat. Requirement/Standard: Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			
D-2 Lease Stipulation **Northeast** Objective: Minimize surface impacts from exploratory drilling. Requirement/Standard: Construction of permanent or gravel oil and gas facilities shall be prohibited for exploratory drilling. Use of a previously constructed road or pad may be permitted if it is environmentally preferred. **Northwest** Objective: Same. Requirement/Standard: Exploratory drilling shall be limited to temporary facilities such as ice pads, ice roads, ice airstrips, temporary platforms, etc., unless the lessee demonstrates that construction of permanent facilities such as gravel airstrips, storage pads, and connecting roads is environmentally preferable or necessary to carry out exploration more economically.	***D-2 Lease Stipulation*** Objective: Minimize surface impacts from exploratory drilling. Requirement/Standard: Construction of permanent or gravel oil and gas facilities shall be prohibited for exploratory drilling. Use of a previously constructed road or pad may be permitted if it is environmentally preferred. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

FACILITY DESIGN AND CONSTRUCTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
E-1 Required Operating Procedure **Northeast** Objective: Protect subsistence use and access to traditional subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish and wildlife resources. Requirement/Standard: All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to traditional subsistence hunting and fishing areas. The authorized officer will consult with appropriate federal, State, and North Slope Borough regulatory and resources agencies prior to approving construction of roads. Subject to approval by the authorized officer, the construction, operation and maintenance of oil field roads is the responsibility of the lessee unless the construction, operation, and maintenance of roads are assumed by the appropriate governing entity. **Northwest** Objective: Same. Requirement/Standard: All roads must be designed, constructed, maintained and operated to minimize environmental impacts and to protect subsistence use and access to traditional subsistence hunting and fishing areas. Subject to approval by the authorized officer, the construction, operation and maintenance of oil field roads is the responsibility of the lessee. **Note**: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. This preserves the opportunity to plan, design and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within the NPR-A.	***E-1 Best Management Practice*** Objective: Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish and wildlife resources. Requirement/Standard: All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas. The authorized officer will consult with appropriate federal, State, and North Slope Borough regulatory and resources agencies prior to approving construction of roads. Subject to approval by the authorized officer, the construction, operation and maintenance of oil and gas field roads is the responsibility of the lessee unless the construction, operation, and maintenance of roads are assumed by the appropriate governing entity.			

FACILITY DESIGN AND CONSTRUCTION

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td><i>E-2 Lease Stipulation</i>
Northeast
<u>Objective</u>: Protect fish-bearing waterbodies, water quality, and aquatic habitats.
<u>Requirement/Standard:</u> Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high watermark. Essential pipeline and road crossings will be permitted on a case-by-case basis. Note: Also refer to Area-Specific Stipulations and Required Operating Procedures for Rivers Area (<i>Lease Stipulation K-1</i>) and Deep Water Lakes (<i>Lease Stipulation K-2</i>).
Construction camps are prohibited on frozen lakes and river ice. Siting of construction camps on river sand and gravel bars is allowed and, where feasible, encouraged. Where leveling of trailers or modules is required and the surface has a vegetative mat, leveling shall be accomplished through blocking rather than use of a bulldozer.
Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: The design and location of permanent oil and gas facilities within 500 feet of fish-bearing or 100 feet of non-fish-bearing waterbodies will only be approved on a case-by-case basis if the lessee can demonstrate that impacts to fish, water quality, and aquatic and riparian habitats are minimal. (Note: Also refer to Area-Specific Stipulations and Required Operating Procedures for Rivers (Stipulation K-1) and Deep Water Lakes (Stipulation K-2)).</td><td colspan="4"><i>E-2 Lease Stipulation</i>
<u>Objective</u>: Protect fish-bearing waterbodies, water quality, and aquatic habitats.
<u>Requirement/Standard:</u> Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high watermark of fish-bearing waterbodies. Essential pipeline and road crossings will be permitted on a case-by-case basis. Note: Also refer to Area-Specific Stipulations and Best Management Practices for Rivers Area (<i>Lease Stipulation K-1</i>) and Deep Water Lakes (<i>Lease Stipulation K-2</i>).
Construction camps are prohibited on frozen lakes and river ice. Siting of construction camps on river sand and gravel bars is allowed and encouraged. Where leveling of trailers or modules is required and the surface has a vegetative mat, leveling shall be accomplished through blocking rather than use of a bulldozer.</td></tr>
<tr><td><i>E-3 Lease Stipulation</i>
Northeast
<u>Objective</u>: Maintain free passage of marine and anadromous fish and protect subsistence use and access to traditional subsistence hunting and fishing.
<u>Requirement/Standard</u>: Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded drilling structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program, developed in consultation with appropriate federal, State, and</td><td colspan="4"><i>E-3 Lease Stipulation</i>
<u>Objective</u>: Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.
<u>Requirement/Standard:</u> Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded drilling structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program, developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, shall be required to address the objectives of water quality and free passage of fish.
<i>(Text is same as in Northeast NPR-A 2008 Record of Decision)</i></td></tr>
</table>

FACILITY DESIGN AND CONSTRUCTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
North Slope Borough regulatory and resource agencies, shall be required to address the objectives of water quality and free passage of fish. **Northwest** Objective: Maintain free passage of marine and anadromous fish, and protect subsistence use and access to traditional subsistence hunting and fishing. Requirement/Standard: Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program may be required to address the objectives of water quality and free passage of fish.				
E-4 Required Operating Procedure **Northeast** Objective: Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents. Requirement/Standard: All pipelines shall be designed, constructed, and operated under an authorized officer-approved quality assurance/quality control plan that is specific to the product transported and shall be constructed to accommodate the best available technology for detecting and preventing corrosion or mechanical defects during routine structural integrity inspections. **Northwest** Objective: Same. Requirement/Standard: All pipelines shall be designed, constructed, and operated under an authorized officer-approved quality assurance/quality control plan that is specific to the product transported.	***E-4 Best Management Practice*** Objective: Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents. Requirement/Standard: All pipelines shall be designed, constructed, and operated under an authorized officer-approved quality assurance/quality control plan that is specific to the product transported and shall be constructed to accommodate the best available technology for detecting and preventing corrosion or mechanical defects during routine structural integrity inspections. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

FACILITY DESIGN AND CONSTRUCTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
E-5 Required Operating Procedure **Northeast** Objective: Minimize impacts of the development footprint. Requirement/Standard: Facilities shall be designed and located to minimize the development footprint to the maximum extent practicable considering environmental, economic, safety, and social impacts. Issues and methods that are to be considered include: (a) use of maximum feasible extended-reach drilling for production drilling to minimize the number of pads and the network of roads between pads; (b) sharing facilities with existing development when prudent and technically feasible; (c) collocation of all oil and gas facilities, except airstrips, docks, and seawater-treatment plants, with drill pads; (d) integration of airstrips with roads; (e) use of gravel-reduction technologies, e.g., insulated or pile-supported pads. **Note**: Where aircraft traffic is a concern, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations. **Northwest** Objective: Same. Requirement/Standard: Facilities shall be designed and located to minimize development footprint to the maximum extent practicable considering environmental, economic, and social impacts. **Note:** Where aircraft traffic is an issue, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.	***E-5 Best Management Practice*** Objective: Minimize impacts of the development footprint. Requirement/Standard: Facilities shall be designed and located to minimize the development footprint. Issues and methods that are to be considered include: (a) use of maximum extended-reach drilling for production drilling to minimize the number of pads and the network of roads between pads; (b) sharing facilities with existing development; (c) collocation of all oil and gas facilities, except airstrips, docks, and seawater-treatment plants, with drill pads; (d) integration of airstrips with roads; (e) use of gravel-reduction technologies, e.g., insulated or pile-supported pads, (f) coordination of facilities with infrastructure in support of offshore development. **Note**: Where aircraft traffic is a concern, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.			
E-6 Required Operating Procedure **Northeast** Objective: Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage. Requirement/Standard: Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow. **Note**: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.	***E-6 Best Management Practice*** Objective: Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage. Requirement/Standard: Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow. **Note**: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

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Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
Northwest Objective: Reduce the potential for ice-jam flooding, erosion, alteration of natural drainage patterns, and restriction of fish passage. Requirement/Standard: Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, maintain natural drainage, and minimal adverse effects to natural stream flow. **Note**: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.				
E-7 Required Operating Procedure **Northeast** Objective: Minimize disruption of caribou movement and subsistence use. Requirement/Standard: Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in traditional subsistence activities. Listed below are the accepted design practices: a. Above ground pipelines shall be elevated a minimum of 7 feet as measured from the ground to the bottom of the pipeline at vertical support members. b. In areas where facilities or terrain may funnel caribou movement, ramps over pipelines, buried pipelines, or pipelines buried under roads may be required by the authorized officer after consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility). c. A minimum distance of 500 feet between pipelines and roads shall be maintained. Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad. Where it is not feasible to separate pipelines and roads, alternative pipeline routes, designs and possible burial within the road will be considered by the authorized officer. **Northwest** Objective: Same. Requirement/Standard: Same, except: c. A minimum distance of 500 feet between pipelines and roads should be maintained when feasible. Separating roads from	***E-7 Best Management Practice*** Objective: Minimize disruption of caribou movement and subsistence use. Requirement/Standard: Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities. Listed below are the accepted design practices: a. Above-ground pipelines shall be elevated a minimum of 7 feet as measured from the ground to the bottom of the pipeline at vertical support members. b. In areas where facilities or terrain may funnel caribou movement, ramps over pipelines, buried pipelines, or pipelines buried under roads may be required by the authorized officer after consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility). c. A minimum distance of 500 feet between pipelines and roads shall be maintained. Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad. Where it is not feasible to separate pipelines and roads, alternative pipeline routes, designs and possible burial within the road will be considered by the authorized officer. d. Above-ground pipelines shall have a non-reflective finish.			

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Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad.				
E-8 Required Operating Procedure **Northeast** Objective: Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources. Requirement/Standard: Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer. The plan shall be developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies and consider: a. Locations outside the active floodplain. b. Design and construction of gravel mine sites within active floodplains to serve as water reservoirs for future use. c. Potential use of the site for enhancing fish and wildlife habitat. **Northwest** Objective: Same. Requirement/Standard: Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer. The plan shall consider: a. Locations outside the active floodplain. b. Design and construction of gravel mine sites within active floodplains to serve as water reservoirs for future use. c. Potential use of site for enhancing fish and wildlife habitat.	***E-8 Best Management Practice*** Objective: Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources. Requirement/Standard: Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer. The plan shall be developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies and consider: a. Locations outside the active floodplain. b. Design and construction of gravel mine sites within active floodplains to serve as water reservoirs for future use. c. Potential use of the site for enhancing fish and wildlife habitat. d. Potential storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope.			
E-9 Required Operating Procedure **Northeast** Objective: Avoidance of human-caused increases in populations of predators of ground-nesting birds. Requirement/Standard: a. Lessee shall utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee shall provide the authorized officer with an annual report on the use of oil and gas facilities by ravens, raptors, and foxes as nesting, denning, and shelter sites. b. Feeding of wildlife is prohibited and will be subject to non-compliance regulations.	***E-9 Best Management Practice*** Objective: Avoidance of human-caused increases in populations of predators of ground-nesting birds. Requirement/Standard: a. Lessee shall utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee shall provide the authorized officer with an annual report on the use of oil and gas facilities by ravens, raptors, and foxes as nesting, denning, and shelter sites. b. Feeding of wildlife is prohibited and will be subject to non-compliance regulations. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

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Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
Northwest Objective: Same. Requirement/Standard: Lessee shall utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee shall provide the authorized officer with an annual report on the use of oil and gas facilities by ravens, raptors, and foxes as nesting, denning, and shelter sites.				
E-10 Required Operating Procedure **Northeast** Objective: Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions. Requirement/Standard: Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward, unless otherwise required by the Federal Aviation Administration. **Northwest** Objective: Same. Requirement/Standard: Except for safety lighting, illumination of higher structures shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward. All drilling structures, production facilities, and other structures that exceed 20 feet shall be illuminated as outlined above.	***E-10 Best Management Practice*** Objective: Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions. Requirement/Standard: Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward, unless otherwise required by the Federal Aviation Administration. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			
E-11 Required Operating Procedure **Northeast** Objective: Minimize the take of species listed under the Endangered Species Act and minimize the disturbance of other species of interest from direct or indirect interaction with oil and gas facilities. Requirement/Standard: In accordance with the guidance below, before the approval of facility construction, aerial surveys of the following species shall be conducted within any area proposed for development. *Special Conditions in Spectacled and/or Steller's Eiders Habitats:* a. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction, if such construction is within the USFWS North Slope eider survey area and at least 1	***E-11 Best Management Practice*** Objective: Minimize the take of bird species, particularly those listed under the Endangered Species Act and BLM Special Status Species from direct or indirect interaction with oil and gas facilities. Requirement/Standard: In accordance with the guidance below, before the approval of facility construction, aerial surveys of the following species shall be conducted within any area proposed for development. *Special Conditions in Spectacled and/or Steller's Eiders Habitats:* a. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction, if such construction is within the USFWS North Slope eider survey area and at least 1 year outside that area. Results of aerial surveys and habitat mapping may require additional ground nest surveys.			

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Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
year outside that area. Results of aerial surveys and habitat mapping may require additional ground nest surveys. Spectacled and/or Steller's eider surveys shall be conducted following accepted BLM-protocol during the second week of June.	Spectacled and/or Steller's eider surveys shall be conducted following accepted BLM-protocol. Information gained from these surveys shall be used to make infrastructure siting decisions as discussed in subparagraph b, below.			
b. If spectacled and/or Steller's eiders are determined to be present within the proposed development area, the applicant shall consult with the USFWS and BLM in the design and placement of roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, construction of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and introduction of high noise levels.	b. If spectacled and/or Steller's eiders are determined to be present within the proposed development area, the applicant shall work with the USFWS and BLM early in the design process to site roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, location of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and management of high noise levels.			
c. To reduce the possibility of spectacled and/or Steller's eiders colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases which are to be few in number and limited in extent. Exceptions are limited to the following situations, and must be reported to the USFWS when exceptions are authorized: 1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad; 2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or 3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.	c. To reduce the possibility of spectacled and/or Steller's eiders (and, under Alternatives B-1, B-2, and C only, other birds) colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases which are to be few in number and limited in extent. Exceptions are limited to the following situations, and must be reported to the USFWS when exceptions are authorized: 1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad; 2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or 3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.			
d. To reduce the likelihood of spectacled and/or Steller's eiders colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds. Such markings shall be developed through consultation with the USFWS.	d. To reduce the likelihood of spectacled and/or Steller's eiders (and, under Alternatives B-1, B-2, and C only, other birds) colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds. Such markings shall be developed through consultation with the USFWS.			

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td><i>Special Conditions in Yellow-billed Loon Habitats:</i>
a. Aerial surveys shall be conducted by the lessee for at least 3 years before authorization of construction of facilities proposed for development which are within 1 mile of a lake 25 acres or larger in size. These surveys along shorelines of large lakes shall be conducted following accepted BLM protocol during nesting in late June and during brood rearing in late August.
b. Should yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. The default standard mitigation is a 1-mile buffer around all recorded nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline. Development will generally be prohibited within buffers unless no other option exists.
Northwest
<u>Objective:</u> Same.
<u>Requirement/Standard</u>: In accordance with the guidance below, before the approval of facility construction, aerial surveys of breeding pairs of the following species shall be conducted within any area proposed for development.
<i>Spectacled and/or Steller's Eiders:</i>
Same, except:
c. To reduce the possibility of spectacled and/or Steller's eiders from striking above-ground utility lines (power and communication), such lines shall either be buried in access roads, or suspended on vertical support members, to the extend practical. Support wires associated with communication towers, radio antennas, and other similar facilities, shall be clearly marked along their entire length to improve visibility for low-flying birds. Such markings shall be jointly developed through consultation with USFWS.
<i>Yellow-billed Loon:</i>
Same, except:
b. Should yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. Current accepted mitigation is a 1-mile buffer around all recorded nest sites and a minimum 500-meter buffer around the remainder of the lake shoreline. Development may be prohibited within buffers or activities curtailed while birds are present.</td><td colspan="4"><i>Special Conditions in Yellow-billed Loon Habitats:</i>
a. Aerial surveys shall be conducted by the lessee for at least 3 years before authorization of construction of facilities proposed for development which are within 1 mile of a lake 25 acres or larger in size. These surveys along shorelines of large lakes shall be conducted following accepted BLM protocol during nesting in late June and during brood rearing in late August.
b. Should yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. The default standard mitigation is a 1-mile buffer around all recorded nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline. Development will generally be prohibited within buffers unless no other option exists.
<i>Protections for Birds</i>
a. To reduce the possibility of birds colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases, which are to be few in number and limited in extent. Exceptions are limited to the following situations:
1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad;
2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or
3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.
b. To reduce the likelihood of birds colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds. Such markings shall be developed through consultation with the USFWS.</td></tr>
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Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
E-12 Required Operating Procedure **Northeast** Objective: Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities, to conserve important habitat types during development. Requirement/Standard: An ecological land classification map of the development area shall be developed before approval of facility construction. The map will integrate geomorphology, surface form, and vegetation at a scale, level of resolution, and level of positional accuracy adequate for detailed analysis of development alternatives. The map shall be prepared in time to plan one season of ground-based wildlife surveys, if deemed necessary by the authorized officer, before approval of the exact facility location and facility construction. **Northwest** Objective: Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities, to conserve important habitat types, including wetlands, during development. Requirement/Standard: Same.	***E-12 Best Management Practice*** Objective: Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities, to conserve important habitat types during development. Requirement/Standard: An ecological land classification map of the development area shall be developed before approval of facility construction. The map will integrate geomorphology, surface form, and vegetation at a scale, level of resolution, and level of positional accuracy adequate for detailed analysis of development alternatives. The map shall be prepared in time to plan one season of ground-based wildlife surveys, if deemed necessary by the authorized officer, before approval of the exact facility location and facility construction. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			
E-13 Required Operating Procedure **Northeast** Objective: Protect cultural and paleontological resources. Requirement/Standard: Lessees shall conduct a cultural and paleontological resources survey prior to any ground-disturbing activity. Upon finding any potential cultural or paleontological resource, the lessee or their designated representative shall notify the authorized officer and suspend all operations in the immediate area of such discovery until written authorization to proceed is issued by the authorized officer. **Northwest** Same.	***E-13 Best Management Practice*** Objective: Protect cultural and paleontological resources. Requirement/Standard: Lessees shall conduct a cultural and paleontological resources survey prior to any ground-disturbing activity. Upon finding any potential cultural or paleontological resource, the lessee or their designated representative shall notify the authorized officer and suspend all operations in the immediate area of such discovery until written authorization to proceed is issued by the authorized officer. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

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<tr><td><i>E-14 Required Operating Procedure</i>
Northeast
Objective: Ensure the passage of fish at stream crossings.
Requirement/Standard: To ensure that crossings provide for fish passage, all proposed crossing designs shall adhere to the best management practices outlined in “Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain” by McDonald et al. (1994), “Fundamentals of Culvert Design for Passage of Weak-Swimming Fish” by Behlke et al. (1991), and other generally accepted best management procedures prescribed by the authorized officer. To adhere to these best management practices, at least 3 years of hydrologic and fish data shall be collected by the lessee for any proposed crossing of a stream whose structure is designed to occur, wholly or partially, below the stream’s ordinary high watermark. These data shall include, but are not limited to, the range of water levels (highest and lowest) at the location of the planned crossing, and the seasonal distribution and composition of fish populations using the stream.
Northwest
No comparable provision.</td><td colspan="4"><i>E-14 Best Management Practice</i>
Objective: Ensure the passage of fish at stream crossings.
Requirement/Standard: To ensure that crossings provide for fish passage, all proposed crossing designs shall adhere to the best management practices outlined in “Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain” by McDonald et al. (1994), “Fundamentals of Culvert Design for Passage of Weak-Swimming Fish” by Behlke et al. (1991), and other generally accepted best management procedures prescribed by the authorized officer. To adhere to these best management practices, at least 3 years of hydrologic and fish data shall be collected by the lessee for any proposed crossing of a stream whose structure is designed to occur, wholly or partially, below the stream’s ordinary high watermark. These data shall include, but are not limited to, the range of water levels (highest and lowest) at the location of the planned crossing, and the seasonal distribution and composition of fish populations using the stream.
<i>(Text is same as in Northeast NPR-A 2008 Record of Decision)</i></td></tr>
<tr><td><i>E-15 Required Operating Procedure</i>
Northeast
Objective: Prevent or minimize the loss of nesting habitat for cliff nesting raptors.
Requirement/Standard:
a. Removal of greater than 100 cubic yards of sand and/or gravel from cliffs shall be prohibited.
b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.
Northwest
No comparable provision.
Colville River Special Area Management Plan Protection 9
Objective: Minimize impacts from sand and/or gravel extraction to arctic peregrine falcons in the Colville River Special Area.
Requirement/Standard: To reduce impacts to arctic peregrine falcons in the Colville River Special Area from sand or gravel extraction the following measures apply:</td><td colspan="4"><i>E-15 Best Management Practice</i>
Objective: Prevent or minimize the loss of nesting habitat for cliff nesting raptors.
Requirement/Standard:
a. Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs shall be prohibited.
b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.
<i>(Text is same as in Northeast NPR-A 2008 Record of Decision)</i>
<i>(Colville River Special Area Management Plan Protection 9 would not be changed.)</i></td></tr>
</table>

FACILITY DESIGN AND CONSTRUCTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
a. Removal of greater than 100 cubic yards of sand and/or gravel from cliffs shall be prohibited. b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.				
E-16 Required Operating Procedure **Northeast** Objective: Prevent or minimize the loss of raptors due to electrocution by powerlines. Requirement/Standard: Comply with the most up-to-date industry-accepted suggested practices for raptor protection on powerlines. Current accepted standards were published in “Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006” in 2006 by the Avian Power Line Interaction Committee and are updated as needed. **Northwest** No comparable provision. **Colville River Special Area Management Plan-Protection 8** Objective: Minimize impacts to arctic peregrine falcon in the CRSA from power lines. Requirement/Standard: To minimize impacts to arctic peregrine falcons in the Colville River Special Area from the powerlines, construction projects will comply with the most up-to-date suggested practices for arctic peregrine falcon protection on powerlines. All powerlines and poles shall be designed and constructed in a manner which reflects safe configurations to prevent death of arctic peregrine falcons by electrocution.	***E-16 Best Management Practice*** Objective: Prevent or minimize the loss of raptors due to electrocution by powerlines. Requirement/Standard: Comply with the most up-to-date industry-accepted suggested practices for raptor protection on powerlines. Current accepted standards were published in “Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006” in 2006 by the Avian Power Line Interaction Committee and are updated as needed. *(Text is same as in Northeast NPR-A 2008 Record of Decision)* *(Colville River Special Area Management Plan Protection 8 would not be changed.)*			
E-17 Stipulation/Required Operating Procedure **Northeast** *(This measure is to be incorporated as a stipulation in new and renewed leases. It is a required operating procedure for existing leases and will be required for any relevant permanent facilities.)* Objective: Minimize impacts to important spectacled eider nesting habitat. Requirement/Standard: With the exception of pipelines, no (a) permanent oil and gas facilities, (b) material sites, or (c) staging areas that would occupy land through more than one winter season would be permitted in spectacled eider nesting and breeding habitat identified by the USFWS as being “high” density	***E-17 Stipulation/Best Management Practice*** No comparable provision. (See E-11 Best Management Practice)			

FACILITY DESIGN AND CONSTRUCTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
(≥1.06 eiders per square mile) using the best available long-term data from the Annual Eider Breeding Survey at the time development is proposed. **Northwest** No comparable provision.				
E-18 Required Operating Procedure **Northeast** Objective: Avoid and reduce temporary impacts to productivity from disturbance near Steller's and/or spectacled eider nests. Requirement/Standard: Ground-level activity (by vehicle or on foot) within 200 meters of occupied Steller's and/or spectacled eider nests, from June 1 through August 15, will be restricted to existing thoroughfares, such as pads and roads. Construction of permanent facilities, placement of fill, alteration of habitat, and introduction of high noise levels within 200 meters of occupied Steller's and/or spectacled eider nests will be prohibited. In instances where summer (June 1 through August 15) support/construction activity must occur off existing thoroughfares, USFWS-approved nest surveys must be conducted during mid-June prior to the approval of the activity. Collected data would be used to evaluate whether the action could occur based on employment of a 200-meter buffer around nests or if the activity would be delayed until after mid-August once ducklings are mobile and have left the nest site. The BLM will also work with the USFWS to schedule oil spill response training in riverine, marine, and inter-tidal areas that occurs within 200 meters of shore outside sensitive nesting/brood-rearing periods or conduct nest surveys. The protocol and timing of nest surveys for Steller's and/or spectacled eiders will be determined in cooperation with the USFWS, and must be approved by the USFWS. Surveys should be supervised by biologists who have previous experience with Steller's and/or spectacled eider nest surveys. **Northwest** No comparable provision.	***E-18 Best Management Practice*** Objective: Avoid and reduce temporary impacts to productivity from disturbance near Steller's and/or spectacled eider nests. Requirement/Standard: Ground-level activity (by vehicle or on foot) within 200 meters of occupied Steller's and/or spectacled eider nests, from June 1 through August 15, will be restricted to existing thoroughfares, such as pads and roads. Construction of permanent facilities, placement of fill, alteration of habitat, and introduction of high noise levels within 200 meters of occupied Steller's and/or spectacled eider nests will be prohibited. In instances where summer (June 1 through August 15) support/construction activity must occur off existing thoroughfares, USFWS-approved nest surveys must be conducted during mid-June prior to the approval of the activity. Collected data will be used to evaluate whether the action could occur based on employment of a 200-meter buffer around nests or if the activity would be delayed until after mid-August once ducklings are mobile and have left the nest site. The BLM will also work with the USFWS to schedule oil spill response training in riverine, marine, and inter-tidal areas that occurs within 200 meters of shore outside sensitive nesting/brood-rearing periods or conduct nest surveys. The protocol and timing of nest surveys for Steller's and/or spectacled eiders will be determined in cooperation with the USFWS, and must be approved by the USFWS. Surveys should be supervised by biologists who have previous experience with Steller's and/or spectacled eider nest surveys. *(Text is same as in Northeast NPR-A 2008 Record of Decision)*			

FACILITY DESIGN AND CONSTRUCTION

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>No comparable provision.</td><td colspan="4">*E-19 Best Management Practice*
Objective: Provide information to be used in monitoring and assessing wildlife movements during and after construction.
Requirement/Standard: A representation, in the form of ArcGIS-compatible shape-files, of all new infrastructure construction shall be provided to the authorized officer. During the planning and permitting phase, shape-files representing proposed locations shall be provided. Within 6 months of construction completion, shape-files (within GPS accuracy) of all new infrastructure shall be provided. Infrastructure includes all gravel roads and pads, facilities built on pads, pipelines and independently constructed powerlines (as opposed to those incorporated in pipeline design). Gravel pads shall be included as polygon feature. Roads, pipelines, and powerlines may be represented as line features but must include ancillary data to denote width, number pipes, etc. Poles for power lines may be represented as point features. Ancillary data shall include construction beginning and ending dates.</td></tr>
<tr><td>No comparable provision.</td><td colspan="4">*E-20 Best Management Practice*
NOTE: This best management practice is only applicable to Alternative B-2. There would be no comparable provision for any of the other alternatives.
Objective: Manage permitted activities to meet Visual Resource Management class objectives described below.
Class I: Natural ecological changes and very limited management activity are allowed. The level of change to the characteristic landscape should be very low and must not attract attention.
Class II: The level of change to the characteristic landscape should be low. Management activities may be seen, but should not dominate the view of the casual observer. Any changes should repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
Class III: The level of change to the characteristic landscape should be moderate. Management activities may attract attention, but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
Class IV: The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize impacts through location and design by repeating form, line, color, and texture.
Requirement/Standard: At the time of application for construction of permanent facilities, the lessee/permittee shall, after consultation with the authorized officer, submit a plan to best minimize visual impacts, consistent with the Visual Resource Management class for the lands on which facilities would be located. A photo simulation of the proposed facilities may be a necessary element of the plan.</td></tr>
</table>

USE OF AIRCRAFT FOR PERMITTED ACTIVITIES

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td><i>F-1 Required Operating Procedure</i>
Northeast
Objective: Minimize the effects of low-flying aircraft on wildlife, traditional subsistence activities, and local communities.
Requirement/Standard: The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines (Note: This required operating procedure is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objectives of the stipulations and required operating procedures. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.):</td><td colspan="4"><i>F-1 Best Management Practice</i>
Objective: Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.
Requirement/Standard: The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines (Note: This best management practice is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objectives of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.):</td></tr>
<tr><td>a. Aircraft shall maintain an altitude of at least 1,500 feet above ground level when within 0.5 mile of cliffs identified as raptor nesting sites from April 15 through August 15 and within 0.5 mile of known gyrfalcon nest sites from March 15 to August 15, unless doing so would endanger human life or violate safe flying practices. Permittees shall obtain information from the BLM necessary to plan flight routes when routes may go near falcon nests.</td><td colspan="4">a. Aircraft shall maintain an altitude of at least 1,500 feet above ground level when within 0.5 mile of cliffs identified as raptor nesting sites from April 15 through August 15 and within 0.5 mile of known gyrfalcon nest sites from March 15 to August 15, unless doing so would endanger human life or violate safe flying practices. Permittees shall obtain information from the BLM necessary to plan flight routes when routes may go near falcon nests.</td></tr>
<tr><td>b. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, unless doing so would endanger human life or violate safe flying practices. Caribou wintering areas will be defined annually by the authorized officer. The authorized officer will consult directly with the Alaska Department of Fish and Game in annually defining caribou winter ranges.</td><td colspan="4">b. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, unless doing so would endanger human life or violate safe flying practices. Caribou wintering areas will be defined annually by the authorized officer. The BLM will consult directly with the Alaska Department of Fish and Game in annually defining caribou winter ranges.</td></tr>
<tr><td>c. Land user shall submit an aircraft use plan as part of an oil and gas exploration or development proposal. The plan shall address strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Proposed aircraft use plans should be reviewed by appropriate federal, State, and borough agencies. Consultations with these same agencies will be required if unacceptable disturbance is identified by subsistence users. Adjustments, including possible suspension of all flights, may be required by the authorized officer if resulting disturbance is determined to be unacceptable. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies</td><td colspan="4">c. Land user shall submit an aircraft use plan as part of an oil and gas exploration or development proposal. The plan shall address strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Proposed aircraft use plans should be reviewed by appropriate federal, State, and borough agencies. Consultations with these same agencies will be required if unacceptable disturbance is identified by subsistence users. Adjustments, including possible suspension of all flights, may be required by the authorized officer if resulting disturbance is determined to be unacceptable. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered to allow larger aircraft to be employed, resulting in fewer flights to the facility.</td></tr>
</table>

USE OF AIRCRAFT FOR PERMITTED ACTIVITIES

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered so as to allow larger aircraft to be employed, resulting in fewer flights to the facility.
d. Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum.
e. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area [Map 2-1K] from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area [Map 2-1K] should be minimized from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices.
Northwest
Objective: Same.
Requirement/Standard: Same, except:
The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines:
b. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, unless doing so would endanger human life or violate safe flying practices. Caribou wintering areas will be defined annually by the authorized officer.
c. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered so as to allow larger aircraft to be employed, resulting in a fewer number of flights to the facility.
e. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Caribou Study Area (See Map 2-1K]) from June 15 through July 31, unless doing so would endanger human life or violate safe flying practices.
f. Aircraft shall maintain an altitude of at least 2,000 feet above</td><td colspan="4">d. Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum.
e. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area (Maps 2-3K and 2-4K, depending upon alternative) from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices. Aircraft use (including fixed wing and helicopter) by oil and gas lessees in the Goose Molting Area (Maps 2-3K or 2-4K) should be minimized from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices.
f. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Utukok River Uplands Special Area from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices. (Note: The boundary of the Utukok River Uplands Special Area differs among Alternatives B-1 through D. See Maps 2-2, 2-3, and 2-4.)
g. (Alternative B-2 only) Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as an aircraft approaches, the aircraft is too close and must break away.
h. (Alternative B-2 only) Fixed wing aircraft used as part of a BLM-authorized activity along the coast shall maintain minimum altitude of 2,000 feet and a 0.5-mile buffer from walrus haulouts, unless doing so would endanger human life or violate safe flying practices. Helicopters used as part of a BLM-authorized activity along the coast shall maintain minimum altitude of 3,000 feet and a 1-mile buffer from walrus haulouts, unless doing so would endanger human life or violate safe flying practices.
i. (Alternative B-2 only) Aircraft used as part of a BLM-authorized activity along the coast and shore fast ice zone shall maintain minimum altitude of 3,000 feet and a buffer of 1 mile from aggregations of seals, unless doing so would endanger human life or violate safe flying practices.</td></tr>
</table>

USE OF AIRCRAFT FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
ground level (except for takeoffs and landings) over the Caribou Coastal Insect-Relief Areas (Map 91 in the Northwest NPR-A Final IAP/EIS [i.e., the 0.75-mile coastal area identified in Stipulation K-6]) from June 15 through July 31, unless doing so would endanger human life or violate safe flying practices. **Colville River Special Area Management Plan-Protection 3** Objective: Minimize the effects of low-flying aircraft on arctic peregrine falcons in the Colville River Special Area. Requirement/Standard: To minimize disturbance to nesting arctic peregrine falcons, aircraft authorized by BLM are required to maintain an altitude of at least 1,500 feet above ground level when within 0.5 mile of cliffs identified as arctic peregrine falcon nesting sites from April 15 through August 15. This protection is not intended to restrict flights necessary to conduct wildlife surveys to obtain information necessary to satisfy wildlife data collection requirements. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.	*(Colville River Special Area Management Plan Protection 3 would not be changed.)*			

OIL AND GAS FIELD ABANDONMENT

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
G-1 Lease Stipulation **Northeast** Objective: Ensure the final disposition of the land meets the current and future needs of the public. Requirement/Standard: Upon abandonment or expiration of the lease, all oil- and gas-related facilities shall be removed and sites rehabilitated to as near the original condition as practicable, subject to the review of the authorized officer. The authorized officer may determine that it is in the best interest of the public to retain some or all facilities. Within the Goose Molting Area, the authorized officer, when determining if it is in the best interest of the public to retain a facility, will consider the impacts of retention to molting geese and goose molting habitat. **Northwest** Objective: Same. Requirement/Standard: Upon abandonment or expiration of the	***G-1 Lease Stipulation*** Objective: Ensure long-term reclamation of land to its previous condition and use. Requirement/Standard: Prior to final abandonment, land used for oil and gas infrastructure—including but not limited to well pads, production facilities, access roads, and airstrips—shall be reclaimed to ensure eventual restoration of ecosystem function. The leaseholder shall develop and implement an abandonment and reclamation plan approved by the BLM. The plan shall describe short-term stability, visual, hydrological, and productivity objectives and steps to be taken to ensure eventual ecosystem restoration to the land's previous hydrological, vegetative, and habitat condition. The BLM may grant exceptions to satisfy stated environmental or public purposes.			

OIL AND GAS FIELD ABANDONMENT

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
lease, all oil- and gas-related facilities shall be removed and sites rehabilitated to as near the original condition as practicable, subject to the review of the authorized officer. The authorized officer may determine that it is in the best interest of the public to retain some or all facilities.				

SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
H-1 Required Operating Procedure **Northeast** Objective: Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and oil and gas and related activities. Requirement/Standard: Lessee/permittee shall consult directly with affected communities using the following guidelines: a. Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence communities, the North Slope Borough, and the National Petroleum Reserve-Alaska Subsistence Advisory Panel to discuss the siting, timing, and methods of their proposed operations to help discover local traditional and scientific knowledge, resulting in measures that minimize impacts to subsistence uses. Through this consultation, the applicant shall make every reasonable effort, including such mechanisms as conflict avoidance agreements and mitigating measures, to ensure that proposed activities will not result in unreasonable interference with subsistence activities. b. The applicant shall submit documentation of consultation efforts as part of its operations plan. Applicants should submit the proposed plan of operations to provide an adequate time for review and comment by the National Petroleum Reserve-Alaska Subsistence Advisory Panel and to allow time for formal government-to-government consultation with Native Tribal governments. The applicant shall submit documentation of its consultation efforts and a written plan that shows how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. Operations plans must include a discussion of the potential effects of the proposed operation,	***H-1 Best Management Practice*** Objective: Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities. Requirement/Standard: Lessee/permittee shall consult directly with affected communities using the following guidelines: a. Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence communities, the North Slope Borough, and the National Petroleum Reserve-Alaska Subsistence Advisory Panel to discuss the siting, timing and methods of their proposed operations to help discover local traditional and scientific knowledge, resulting in measures that minimize impacts to subsistence uses. Through this consultation, the applicant shall make every reasonable effort, including such mechanisms as conflict avoidance agreements and mitigating measures, to ensure that proposed activities will not result in unreasonable interference with subsistence activities. In the event that no agreement is reached between the parties, the authorized officer shall consult with the directly involved parties and determine which activities will occur, including the timeframes. b. The applicant shall submit documentation of consultation efforts as part of its operations plan. Applicants should submit the proposed plan of operations to the National Petroleum Reserve-Alaska Subsistence Advisory Panel for review and comment. The applicant must allow time for the BLM to conduct formal government-to-government consultation with Native Tribal governments if the proposed action requires it.			

SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>and the proposed operation in combination with other existing or reasonably foreseeable operations.
c. A subsistence plan addressing the following items must be submitted:
1. A detailed description of the activity(ies) to take place (including the use of aircraft).
2. A description of how the lessee/permittee will minimize and/or deal with any potential impacts identified by the authorized officer during the consultation process.
3. A detailed description of the monitoring effort to take place, including process, procedures, personnel involved and points of contact both at the work site and in the local community.
4. Communication elements to provide information on how the applicant will keep potentially affected individuals and communities up-to-date on the progress of the activities and locations of possible, short-term conflicts (if any) with subsistence activities. Communication methods could include holding community meetings, open house meetings, workshops, newsletters, radio and television announcements, etc.
5. Procedures necessary to facilitate access by subsistence users to conduct their activities.
In the event that no agreement is reached between the parties, the authorized officer shall consult with the directly involved parties and determine which activities will occur, including the timeframes. During development, monitoring plans must be established for new permanent facilities, including pipelines, to assess an appropriate range of potential effects on resources and subsistence as determined on a case-by-case basis given the nature and location of the facilities. The scope, intensity, and duration of such plans will be established in consultation with the authorized officer and NPR-A Subsistence Advisory Panel. Permittees that propose barging facilities, equipment, supplies, or other materials to NPR-A in support of oil and gas activities in the [Northeast NPR-A] planning area shall notify, confer, and coordinate with the Alaska Eskimo Whaling Commission, the appropriate local community whaling captains' associations, and the North Slope Borough to minimize impacts from the proposed barging on subsistence whaling activities.</td><td colspan="4">c. A plan shall be developed that shows how the activity, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. The plan will also describe the methods used to monitor the effects of the activity on subsistence use. The plan shall be submitted to the BLM as part of the plan of operations. The plan should address the following items:
1. A detailed description of the activity(ies) to take place (including the use of aircraft).
2. A description of how the lessee/permittee will minimize and/or deal with any potential impacts identified by the authorized officer during the consultation process.
3. A detailed description of the monitoring effort to take place, including process, procedures, personnel involved and points of contact both at the work site and in the local community.
4. Communication elements to provide information on how the applicant will keep potentially affected individuals and communities up-to-date on the progress of the activities and locations of possible, short-term conflicts (if any) with subsistence activities. Communication methods could include holding community meetings, open house meetings, workshops, newsletters, radio and television announcements, etc.
5. Procedures necessary to facilitate access by subsistence users to conduct their activities.
6. (**Alternative B-2 only**) Barge operators requiring a BLM permit are required to demonstrate that barging activities will not have unmitigable adverse impacts on the availability of marine mammals to subsistence hunters.
7. (**Alternative B-2 only**) All vessels over 50 ft. in length engaged in operations requiring a BLM permit must have an Automatic Identification System (AIS) transponder system on the vessel.
d. During development, monitoring plans must be established for new permanent facilities, including pipelines, to assess an appropriate range of potential effects on resources and subsistence as determined on a case-by-case basis given the nature and location of the facilities. The scope, intensity, and duration of such plans will be established in consultation with the authorized officer and NPR-A Subsistence Advisory Panel.
e. Permittees that propose barging facilities, equipment, supplies, or other materials to NPR-A in support of oil and gas activities in the NPR-A shall notify, confer, and coordinate with the Alaska Eskimo Whaling Commission, the appropriate local community whaling captains' associations, and the North Slope Borough to minimize impacts from the proposed barging on subsistence whaling activities.</td></tr>
</table>

SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
Northwest Objective: Same. Requirement/Standard: Same, except: a. Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence communities, the North Slope Borough, and the NPR-A Subsistence Advisory Panel to discuss the siting, timing and methods of proposed operations. Through this consultation, the applicant shall make every reasonable effort, including such mechanisms as conflict avoidance agreements and mitigating measures, to ensure that proposed activities will not result in unreasonable interference with subsistence activities. **Note**: The final unnumbered paragraph in the Northeast NPR-A Record of Decision is not included in the Northwest NPR-A Record of Decision, but the wording of the first sentence is included in numbered bullet 6 and the next two sentences are in numbered bullet 7. There is no comparable statement to the last sentence in the paragraph.				
H-2 Required Operating Procedure **Northeast** Objective: Prevent unreasonable conflicts between subsistence activities and geophysical (seismic) exploration. Requirement/Standard: In addition to the consultation process described in Required Operating Procedure H-1 for permitted activities, before applying for permits to conduct geophysical (seismic) exploration, the applicant shall (1) consult with local communities and residents and (2) notify the local search and rescue organizations of current and recent seismic surveys. For the purpose of this standard, a potentially affected cabin/campsite is defined as any camp or campsite within the boundary of the area subject to proposed geophysical exploration and/or within 1 mile of actual or planned travel routes used to supply the seismic operations while it is in operation. a. Because of the large land area covered by typical geophysical operations and the potential to impact a large number of subsistence users during the exploration season, the permittee/operator will notify in writing all potentially affected long-term cabin and camp users. b. The official recognized list of cabin and campsite users is the North Slope Borough's 2001 (or most current) inventory of cabins and campsites.	***H-2 Best Management Practice*** Objective: Prevent unreasonable conflicts between subsistence activities and geophysical (seismic) exploration. Requirement/Standard: In addition to the consultation process described in Best Management Practice H-1 for permitted activities, before activity to conduct geophysical (seismic) exploration commences, applicants shall notify the local search and rescue organizations of proposed seismic survey locations for that operational season. For the purpose of this standard, a potentially affected cabin/campsite is defined as any camp or campsite used for subsistence purposes and located within the boundary of the area subject to proposed geophysical exploration and/or within 1 mile of actual or planned travel routes used to supply the seismic operations while it is in operation. a. Because of the large land area covered by typical geophysical operations and the potential to impact a large number of subsistence users during the exploration season, the permittee/operator will notify all potentially affected subsistence-use cabin and campsite users. b. The official recognized list of subsistence-use cabin and campsite users is the North Slope Borough's most current inventory of cabins and campsites, which have been identified by the subsistence users' names.			

SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES

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<tr><td>c. A copy of the notification letter and a list of potentially affected users shall also be provided to the office of the appropriate Native Tribal government.
d. The authorized officer will prohibit seismic work within 1 mile of any known, long-term, cabin or campsite unless an alternate agreement between the cabin/campsite owner/user is reached through the consultation process and presented to the authorized officer. (Regardless of the consultation outcome, the authorized officer will prohibit wintertime seismic work within 300 feet of a known long-term cabin or campsite.)
e. The permittee shall notify the appropriate local search and rescue (e.g., Nuiqsut Search and Rescue, Atqasuk Search and Rescue) of their current operational location within the NPR-A on a weekly basis. This notification should include a map indicating the current extent of surface use and occupation, as well as areas previously used/occupied during the course of the operation in progress. The purpose of this notification is to allow hunters up-to-date information regarding where seismic exploration is occurring, and has occurred, so that they can plan their hunting trips and access routes accordingly. Identification of the appropriate search and rescue offices to be contacted can be obtained from the NPR-A Subsistence Advisory Panel.

Northwest
Objective: Same.
Requirement/Standard: Same, except:
In addition to the consultation process described above for permitted activities, before applying for permits to conduct geophysical (seismic) exploration, the applicant shall consult with local communities and residents:
c. For the purpose of this standard, potentially affected cabins and campsites are defined as any camp or campsite within the boundary of the area subject to proposed geophysical exploration and/or within 1,200 feet of actual or planned travel routes used to supply the seismic operations while it is in operation.
d. A copy of the notification letter and a list of potentially affected users shall also be provided to the office of the appropriate Native Tribal Government.
e. Based on that consultation, the authorized officer may prohibit seismic work up to 1,200 feet of any known, long-term cabin or campsite. Generally, the authorized officer will allow</td><td colspan="4">c. A copy of the notification letter, a map of the proposed exploration area, and the list of potentially affected users shall also be provided to the office of the appropriate Native Tribal government.
d. The authorized officer will prohibit seismic work within 1 mile of any known subsistence-use cabin or campsite unless an alternate agreement between the cabin/campsite owner/user is reached through the consultation process and presented to the authorized officer. (Regardless of the consultation outcome, the authorized officer will prohibit seismic work within 300 feet of a known subsistence-use cabin or campsite.)
e. The permittee shall notify the appropriate local search and rescue (e.g., Nuiqsut Search and Rescue, Atqasuk Search and Rescue) of their current operational location within the NPR-A on a weekly basis. This notification should include a map indicating the current extent of surface use and occupation, as well as areas previously used/occupied during the course of the operation in progress. The purpose of this notification is to allow hunters up-to-date information regarding where seismic exploration is occurring, and has occurred, so that they can plan their hunting trips and access routes accordingly. Identification of the appropriate search and rescue offices to be contacted can be obtained from the coordinator of the NPR-A Subsistence Advisory Panel in the BLM's Arctic Field Office.</td></tr>
</table>

SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
wintertime seismic work to be conducted within 300 feet of a long-term cabin or campsite that is not in use.				
No comparable provision.	***H-3 Best Management Practice*** Objective: Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals. Requirement/Standard: Hunting and trapping by lessee's/permittee' s employees, agents, and contractors are prohibited when persons are on "work status." Work status is defined as the period during which an individual is under the control and supervision of an employer. Work status is terminated when the individual's shift ends and he/she returns to a public airport or community (e.g., Fairbanks, Barrow, Nuiqsut, or Deadhorse). Use of lessee/permittee facilities, equipment, or transport for personnel access or aid in hunting and trapping is prohibited.			

ORIENTATION PROGRAMS ASSOCIATED WITH PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
I-1 Required Operating Procedure **Northeast** Objective: Minimize cultural and resource conflicts. Requirement/Standard: All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, required operating procedures, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The lessee/permittee shall ensure that all personnel involved in permitted activities shall attend an orientation program at least once a year. The proposed orientation program shall be submitted to the authorized officer for review and approval and should: a. provide sufficient detail to notify personnel of applicable stipulations and required operating procedures as well as inform individuals working on the project of specific types of environmental, social, traditional and cultural concerns that relate to the region. b. Address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid disturbance. c. Include guidance on the preparation, production, and distribution of information cards on endangered and/or threatened species.	***I-1 Best Management Practice*** Objective: Minimize cultural and resource conflicts. Requirement/Standard: All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, best management practices, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The lessee/permittee shall ensure that all personnel involved in permitted activities shall attend an orientation program at least once a year. The proposed orientation program shall be submitted to the authorized officer for review and approval and should: a. provide sufficient detail to notify personnel of applicable stipulations and best management practices as well as inform individuals working on the project of specific types of environmental, social, traditional and cultural concerns that relate to the region. b. Address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid disturbance. c. Include guidance on the preparation, production, and distribution of information cards on endangered and/or threatened species.			

ORIENTATION PROGRAMS ASSOCIATED WITH PERMITTED ACTIVITIES

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
d. Be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel will be operating.	d. Be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel will be operating.			
e. Include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.	e. Include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.			
f. Include information for aircraft personnel concerning subsistence activities and areas/seasons that are particularly sensitive to disturbance by low-flying aircraft. Of special concern is aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall caribou and moose hunting seasons, and flights near North Slope communities.	f. Include information for aircraft personnel concerning subsistence activities and areas/seasons that are particularly sensitive to disturbance by low-flying aircraft. Of special concern is aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall caribou and moose hunting seasons, and flights near North Slope communities.			
g. Provide that individual training is transferable from one facility to another except for elements of the training specific to a particular site.	g. Provide that individual training is transferable from one facility to another except for elements of the training specific to a particular site.			
h. Include on-site records of all personnel who attend the program for so long as the site is active, though not to exceed the 5 most recent years of operations. This record shall include the name and dates(s) of attendance of each attendee.	h. Include on-site records of all personnel who attend the program for so long as the site is active, though not to exceed the 5 most recent years of operations. This record shall include the name and dates(s) of attendance of each attendee.			
i. Include a module discussing bear interaction plans to minimize conflicts between bears and humans.	i. Include a module discussing bear interaction plans to minimize conflicts between bears and humans.			
j. Provide a copy of 43 CFR 3163 regarding Non-Compliance Assessment and Penalties to onsite personnel.	j. Provide a copy of 43 CFR 3163 regarding Non-Compliance Assessment and Penalties to on-site personnel.			
k. Include training designed to ensure strict compliance with local and corporate drug and alcohol policies. This training should be offered to the North Slope Borough Health Department for review and comment.	k. Include training designed to ensure strict compliance with local and corporate drug and alcohol policies. This training should be offered to the North Slope Borough Health Department for review and comment.			
l. Include training developed to train employees on how to prevent transmission of communicable diseases, including sexually transmitted diseases, to the local communities. This training should be offered to the North Slope Borough Health Department for review and comment.	l. Include training developed to train employees on how to prevent transmission of communicable diseases, including sexually transmitted diseases, to the local communities. This training should be offered to the North Slope Borough Health Department for review and comment. *(Same text as in Northeast NPR-A 2008 Record of Decision)*			
Northwest Objective: Same. Requirement/Standard: Same, except that subparagraphs j, k, and l are not included.				

ENDANGERED SPECIES ACT—SECTION 7 CONSULTATION PROCESS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
J. **Northeast** The lease areas may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or to have some other special status. The BLM may recommend modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activities that will contribute to the need to list such a species or their habitat. The BLM may require modifications to or disapprove a proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modification of a designated or proposed critical habitat. The BLM will not approve any activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act as amended, 16 USC § 1531 et seq., including completion of any required procedure for conference or consultation. **Northwest** Same, except characterized as Stipulation J-1.	*J.* The lease areas may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or to have some other special status. The BLM may require modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activities that will contribute to the need to list such a species or their habitat. The BLM may require modifications to or disapprove a proposed activity that is likely to adversely affect a proposed or listed endangered species, threatened species, or critical habitat. The BLM will not approve any activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act as amended, 16 USC § 1531 et seq., including completion of any required procedure for conference or consultation.			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
K-1 Lease Stipulation - Rivers **Northeast** Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values. Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers listed below at the distances identified. (Gravel mines may be located within the active	***K-1 Lease Stipulation/Best Management Practice – Rivers*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternatives, K-1 would be a best management practice. In Alternatives B-1 and B-2, portions of the Colville, Ikpikpuk, Kikiakrorak, Kogosukruk, and Titalik rivers have larger setbacks than in the other alternatives; see below for the details. Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values. Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers listed below at the distances identified. (Gravel mines may be located within the active floodplain consistent with Best Management Practice E-8). On a case-by case basis, and in consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility),			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
floodplain consistent with Required Operating Procedure E-8). With the exception of the Ikpikpuk River, these setbacks are measured from the bank of the river as determined by the hydrology at the time of application. The standard setback is 0.5 mile (from the bank's highest high watermark) and increased to 0.75 mile (from the bank's highest high watermark) where subsistence cabin and campsites are numerous. Along the Colville River and a portion of the Ikpikpuk a 1-mile (from the bank's highest high watermark) setback is required to protect important raptor habitat (for locations along rivers where setback distances change). On a case-by case basis, and in consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings to the main channel will be permitted through setback areas. The above setbacks may not be practical within river deltas. In these situations, permanent facilities shall be designed to withstand a 200-year flood event. a. Colville River: a 1-mile setback from the boundary of NPR-A along the Colville River as determined by cadastral survey to be the highest high watermark on the left (western or northern) bank extending the length of that portion of the river located within the [Northeast NPR-A] planning area. **Note**: The [Northeast NPR-A] planning area excludes conveyed Native lands along the lower reaches of the Colville River. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. **Note**: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within National Petroleum Reserve-Alaska. b. **Ikpikpuk River**: a 0.75-mile setback from each side of the centerline (1.5 miles total) of the Ikpikpuk River extending from the mouth south to section 19, T7N, R11W, U.M. (Umiat Meridian). From section 19, T7N, R11W, U.M., to section 4, T3N, R12W, U.M., a 1-mile setback is required. Beginning at section 4, T3N, R12W, U.M., a 0.5-mile setback from the centerline (1 mile total) will be required to the confluence of the Kigalik River and Maybe Creek. **Note**: The setback distances	essential pipeline and road crossings to the main channel will be permitted through setback areas. The above setbacks may not be practical within river deltas. In these situations, permanent facilities shall be designed to withstand a 200-year flood event. In the below list, if no upper limit for the setback is indicated, the setback extends to the head of the stream as identified in the National Hydrography Dataset. a. **Colville River:** a 1-mile setback (2-mile setback in Alternatives B-1 and B-2) from the boundary of NPR-A where the river determines the boundary along the Colville River as determined by cadastral survey to be the highest high watermark on the left (western or northern) bank and from both banks' ordinary high watermark where BLM-manages both sides of the river up through T5S, R30W, U.M. Above that point to its source at the juncture of Thunder and Storm creeks the setback will be 0.5 mile. **Note**: The planning area excludes conveyed Native lands along the lower reaches of the Colville River. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. **Note**: This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes, though the BLM would encourage minimal use of the setback area. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within National Petroleum Reserve-Alaska. b. **Ikpikpuk River**: a 0.5-mile setback from of the ordinary high watermark of the Ikpikpuk River extending from the mouth south to section 19, T7N, R11W, U.M. From section 19, T7N, R11W, U.M., to section 4, T3N, R12W, U.M., a 1-mile setback is required. Beginning at section. 4, T3N, R12W, U.M., a 0.5-mile setback from the centerline (1 mile total) will be required to the confluence of the Kigalik River and Maybe Creek. In Alternative B-1 and B-2, the setback would be 2 miles from the ordinary high watermark from the mouth of the river upstream through T7 N, R11W, U.M.; above that point the setback would be the same as described above in Alternative B-1 and 1 mile in Alternative B-2. c. **Miguakiak River**: a 0.5-mile setback from the bank's ordinary high watermark. d. **Kikiakrorak and Kogosukruk Rivers**: A 1-mile setback from the top of the bluff (or ordinary high watermark if there is no bluff) on the Kikiakrorak River downstream from T2N., R4W, U.M. and on the Kogosukruk River (including Branch of Kogosukruk River, Henry Creek, and two unnamed tributaries off the southern bank) downstream from T2N, R3W, U.M. In Alternatives B-1 and B-2, the setback would be 2 miles from the top of the bluff (or bank if there is no bluff) for the same waterbodies. The setback from these streams in Alternatives B-1 through D in the named townships and further upstream as applicable will be 0.5 mile from the top of the bluff or bank if there is no bluff. e. **Fish Creek**: a 3-mile setback from the bank's highest high watermark of the creek downstream from the eastern edge of section 31, T11N, R1E., U.M. and a 0.5-mile setback from the bank's highest high watermark farther upstream. f. **Judy Creek**: a 0.5-mile setback from the banks' ordinary high watermark. g. **Ublutuoch (Tiŋmiaqsiugvik) River:** a 0.5-mile setback from the ordinary high water mark. h. **Alaktak River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark. i. **Chipp River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark. j. **Oumalik River**: a 0.5-mile setback from the Oumalik River ordinary high water mark from the mouth			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
only apply to the east bank where the Ikpikpuk River is the [Northeast NPR-A] planning area boundary. c. **Miguakiak River**: a 0.5-mile setback from the bank's highest high watermark. d. **Kikiakrorak and Kogosukruk Rivers**: **Note**: The following discussion refers only to portions of the Kikiakrorak River downstream from T2N, R4W, U.M., and the Kogosukruk River (including the four tributaries off the southern bank) downstream from T2N, R3W, U.M. No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within 1 mile of the top of the bluff (or bank if there is no bluff) on either side of the rivers and several of the Kogosukruk tributaries. e. **Fish Creek**: No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within 3 miles (from the bank's highest high watermark) of the creek downstream from the eastern edge of section 31, T11N, R1E, U.M. or within 0.5 mile (from the bank's highest high watermark) of the creek farther upstream. f. **Judy Creek**: a 0.5-mile setback from the banks' highest high watermark extending from the mouth to the confluence of an unnamed tributary in section 8, T8N, R2W, U.M. g. **Tingmiaksiqvik River**: No permanent oil and gas surface facilities, except essential transportation crossings, would be allowed within 0.5 mile (from the bank's highest high water mark) of this river from its headwaters within section 13, T7N, R1W, U.M. downstream to its confluence with Fish Creek. **Northwest** Objective: Same. Requirement/Standard**:** Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the stream bed and adjacent to the rivers listed below at the distances identified. These setbacks are measured from the centerline of the river as determined by the current hydrology at the time of application. The standard setback is 0.5 mile and increased to 0.75 mile where subsistence cabins and campsites are numerous. Along the Colville River and a portion of the Ikpikpuk a 1-mile setback is required to protect important raptor habitat. (For locations along rivers where setback distances change, see Map 20 in the Final Northwest National Petroleum Reserve-Alaska Integrated Activity Plan/Environmental Impact Statement). On a case-by case basis, and in consultation with	upstream to section 5, T8N, R14W, U.M., and a 0.5-mile setback in and above section 5, T8N, R14W, U.M. k. **Titaluk River**: a 0.5-mile setback from the centerline. In Alternatives B-1 and B-2, the setback would be 2 miles from the centerline from its confluence with the Ikpikpuk River upstream through T7N, R12W, U.M.; above that point the setback would be the same as described above. l. **Kigalik River**: a 0.5-mile setback from the ordinary high water mark. m. **Maybe Creek**: a 0.5-mile setback from the ordinary high water mark. **Topagoruk River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark. o. **Ishuktak Creek**: a 0.5-mile setback from the ordinary high water mark. p. **Meade River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark on BLM-managed lands. **Usuktuk River**: a 0.5-mile setback (1 mile for Alternative B-2) from the ordinary high water mark on BLM-managed lands. r. **Pikroka Creek**: a 0.5-mile setback from the ordinary high water mark. s. **Nigisaktuvik River**: a 0.5-mile (1 mile for Alternative B-2) setback from the Nigisakturik River ordinary high water mark upstream from the confluence with the Meade River to section 1, T11N, R25W, U.M. and a 0.5-mile setback further upstream. t. **Inaru River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark. u. **Kucheak Creek**: a 0.5-mile setback from the ordinary high water mark. v. **Avalik River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark. w. **Niklavik Creek**: a 0.5-mile setback from the ordinary high water mark. x. **Kugrua River**: a 0.5-mile setback from the ordinary high water mark. y. **Kungok River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark on BLM-managed lands. z. **Kolipsun Creek**: a 0.5-mile setback from the ordinary high water mark upstream through T13N, R28W, U.M. aa. **Maguriak Creek**: a 0.5-mile setback from the ordinary high water mark upstream through T12N, R29W, U.M. ab. **Mikigealiak River**: a 0.5-mile setback from the ordinary high water mark upstream through T12N, R30W, U.M. ac. **Kuk River**: a 0.5-mile setback (1 mile for Alternative B-2) from the ordinary high water mark on BLM-managed lands. ad. **Ketik River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark. ae. **Kaolak River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark. af. **Ivisaruk River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark. ag. **Nokotlek River**: a 0.5-mile setback from the ordinary high water mark. ah. **Ongorakvik River**: a 0.5-mile setback from the ordinary high water mark. ai. **Tunalik River**: a 0.5-mile setback from the ordinary high water mark. aj. **Avak River**: a 0.5-mile setback from the ordinary high water mark within the NPR-A.			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings perpendicular to the main channel will be permitted (unless noted otherwise) through setback areas. The above setbacks may not be practical within river deltas. In these situations, permanent facilities shall be designed to withstand a 200-year flood event. a. Colville River: a 1-mile setback from the northern bluff (or bank if there is no bluff) of the Colville River extending the length of that portion of the river within the [Northwest NPR-A] Planning Area. Road crossings intended to solely support oil and gas activities are prohibited. **Note:** This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within NPR-A. b. Ikpikpuk River: a 0.75-mile setback from the centerline of the Ikpikpuk River extending from the mouth south to section 19, T7N, R11W, U.M. From section 19, T7N, R11W, U.M. to section 4, T3N, R12W, U.M., a 1-mile setback is required. Beginning at section 4, T3N, R12W, U.M., a 0.5-mile setback will be required to the confluence of the Kigalik River and Maybe Creek. c. Alaktak River: a 0.75-mile setback from the centerline of the Alaktak River extending from the mouth to the Ikpikpuk River. d. Chipp River: a 0.75-mile setback from the centerline of the Chipp River extending from the mouth to the Ikpikpuk River. e. Oumalik River: a 0.75-mile setback from the centerline of the Oumalik River from the mouth upstream to section 5, T8N, R14W, U.M., and a 0.5-mile setback from section 5, T8N, R14W, U.M., upstream to section 2, T5N, R15W, U.M. f. Titaluk River: a 0.5-mile setback from the centerline of the Titaluk River from the confluence with the Ikpikpuk River upstream to section 1, T2N, R22W, U.M. g. Kigalik River: a 0.5-mile setback from the centerline of the Kigalik River from the confluence with the Ikpikpuk River upstream to the [Northwest NPR-A] Planning area boundary. h. Maybe Creek: a 0.5-mile setback from the centerline of the Maybe Creek from the confluence with the Ikpikpuk River upstream to section 8, T2S R6W, U.M. i. Topagoruk River: a 0.75-mile setback from the centerline of	ak. **Nigu River**: a 0.5-mile setback from the ordinary high water mark from the confluence with the Etivluk River upstream to the boundary of NPR-A al. **Etivluk River**: a 0.5-mile setback from the ordinary high water mark. am. **Ipnavik River**: a 0.5-mile setback from the ordinary high water mark. an. **Kuna River**: a 0.5-mile setback from the ordinary high water mark. ao. **Kiligwa River**: a 0.5-mile setback from the ordinary high water mark. ap. **Nuka River**: a 0.5-mile setback from the ordinary high water mark. aq. **Driftwood Creek**: a 0.5-mile setback from the ordinary high water mark. ar. **Utukok River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark within the NPR-A. as. **Awuna River**: a 0.5-mile setback from the ordinary high water mark. at. **Carbon Creek**: a 0.5-mile setback from the ordinary high water mark. au. **Kokolik River**: a 0.5-mile (1 mile for Alternative B-2) setback from the ordinary high water mark within the NPR-A. av. **(Alternative B-2 only) Keolok Creek:** a 0.5-mile setback from the ordinary high water mark.			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
the Topagoruk River from the mouth upstream to the confluence with Ishuktak Creek. A 0.5-mile setback from each bank upstream from the confluence with the Ishuktak to section 3, T7N, R17W, U.M. j. Ishuktak Creek: a ½-mile setback from the centerline of Ishuktak Creek from the confluence with the Topagoruk River to Sec. 24, T8N, R16W, UM. k. Meade River: a 0.75-mile setback from the centerline of the Meade River upstream to section 6, T6N, R21W, U.M. A 0.5-mile setback from each bank upstream from section 6, T6N, R21W, U.M. to the [Northwest NPR-A] Planning area boundary. l. Usuktuk River: a 0.75-mile setback from the centerline of the Usuktuk River upstream from the confluence with the Meade River to section 36, T10N, R19W, U.M. m. Pikroka Creek a 0.75-mile setback from the centerline of the Pikroka Creek upstream from the confluence with the Meade River to section 11, T8N, R23W, U.M. n. Nigisaktuvik River: a 0.75-mile setback from the centerline of the Nigisaktuvik River upstream from the confluence with the Meade River to section 1, T11N, R25W, U.M. o. Inaru River: a 0.75-mile setback from the centerline. [**Note:** the Northwest NPR-A plan incorrectly indicated that the Inaru River extended upstream to section 17, T15N, R25W, U.M.] p. Kucheak Creek: a 0.75-mile setback from the centerline of Kucheak Creek from the confluence with the Inaru River upstream to section 20, T13N, R24W, U.M. q. Avalik River: a 0.5-mile setback from the centerline of the Avalik River along that portion of the river within the [Northwest NPR-A] Planning area. r. Niklavik Creek: a 0.5-mile setback from the centerline of the Niklavik Creek from the confluence with the Inaru River upstream to section 5, T17N, R21W, U.M.				
Colville River Special Area Management Plan-Protection 1 Objective: Minimize the loss of arctic peregrine falcon nesting habitat in the Colville River Special Area. Requirement/Standard: To minimize the direct loss of arctic peregrine falcon nesting habitat and to protect nest sites in the Colville River Special Area the following protective measures apply: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the stream bed and adjacent to the rivers listed below at the distances identified. On a	*(Colville River Special Area Management Plan Protection 1 would not be changed as part of this plan, except that under Alternatives B-1 and B-2, the setbacks for the Colville, Kikiarorak, and Kogosukruk rivers is widened to 2 miles.)*			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
case-by-case basis, and in consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate; based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings perpendicular to the main channel will be permitted through setback areas. a. Colville River: downstream of the Etivluk River a continuous 1-mile setback measured from the highest high watermark on the left bank (facing downstream); upstream of the Etivluk River a 1-mile setback measured from the ordinary high watermark of the bank on both sides of the river. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes. b. Kikiarorak River: downstream from T2N, R4W, U.M., a continuous 1-mile setback as measured from the top of the bluff (or bank if there is no bluff) of both sides of the river. c. Kogosukruk River: downstream from T2N, R3W, U.M., a continuous 1-mile setback as measured from the top of the bluff (or bank if there is no bluff) of both sides of the river and several of its tributaries.				
K-2 Lease Stipulation--Deep Water Lakes **Northeast** Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes; the loss of spawning, rearing, or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities. Requirement/Standard: Generally, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited on the lake or lakebed and within 0.25 mile of the ordinary high watermark of any deep lake as determined to be in lake zone III (i.e., depth greater than 13 feet [4 meters]; Mellor 1985). On a case-by-case basis in consultation with federal, State and North Slope Borough regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential pipeline(s), road crossings, and other permanent facilities may be considered through the permitting	***K-2 Lease Stipulation/Best Management Practice – Deep Water Lakes*** **Note:** This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternatives, K-2 would be a best management practice. Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities. Requirement/Standard: Generally, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited on the lake or lakebed and within 0.25 mile of the ordinary high watermark of any deep lake as determined to be in lake zone III (i.e., depth greater than 13 feet [4 meters]; Mellor 1985). On a case-by-case basis in consultation with federal, State and North Slope Borough regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential pipeline(s), road crossings, and other permanent facilities may be considered through the permitting process in these areas where the lessee can demonstrate on a site-specific basis that impacts will be minimal.			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
process in these areas where the lessee can demonstrate on a site-specific basis that impacts will be minimal and if it is determined that there is no feasible or prudent alternative. **Northwest** Objective: Same. Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited on the lake or lakebed and within 0.25 mile of the ordinary high watermark of any deep lake as determined to be in lake zone III, i.e., depth >4 meters (Mellor 1985). On a case-by-case basis, and in consultation with federal, State and North Slope Borough regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential pipeline, road crossings, and other permanent facilities may be permitted through or in these areas where the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative.				
K-3a[4] Stipulation - Teshekpuk Lake Shoreline **Northeast** (**Note**: Teshekpuk Lake and islands within the lake (approximately 219,000 acres) will not be available for oil and gas leasing.) Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of this large and regionally significant deep water lake; the loss of cultural and paleontological resources; impacts to subsistence cabins, campsites and associated activities; and to protect fish and wildlife habitat including important insect-relief areas. Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited within 0.25 mile of the ordinary high watermark of Teshekpuk Lake. In addition, no permanent oil and gas facilities, except pipelines, would be allowed in portions of T14–15N, R9W, and T15N, R8W, U.M. greater than 0.25 mile of the ordinary high watermark of Teshekpuk Lake as depicted on Map 2-1. (No alternative procedures will be approved.)	*K-3a Stipulation – Teshekpuk Lake Shoreline* **NOTE: this applies only to Alternative C.** Alternatives B-1 and B-2 have no comparable provision because no non-subsistence permanent infrastructure would be allowed within the Teshekpuk Lake shoreline area. Alternative D also has no comparable provision, but note that Teshekpuk Lake is a deep water lake to which Stipulation K-2 applies. Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of this large and regionally significant deep water lake; the loss of cultural and paleontological resources; impacts to subsistence cabins, campsites and associated activities; and to protect fish and wildlife habitat including important insect-relief areas. Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited within 0.25 mile of the ordinary high watermark of Teshekpuk Lake. In addition, no permanent oil and gas facilities, except pipelines, will be allowed in portions of T14–15 N, R9W, and T15N, R8W, U.M. greater than 0.25 mile of the ordinary high watermark of Teshekpuk Lake as depicted on Map 2-3K. (No waiver, exception, or modification will be approved.)			

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[4] K-3a, K-4a, K-5a, and K-8a all refer to Stipulations K-3, K-4, K-5, and K-8 in the Northeast NPR-A IAP ROD. K-3b, K-4b, K-5b, and K-8b refer to K-3, K-4, K-5, and K-8 in the Northwest NPR-A IAP/ROD.

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
K-3b Lease Stipulation–Dease Inlet, Admiralty Bay, Elson Lagoon, and Associated Barrier Islands **Northwest** Lease stipulations for Dease Inlet, Admiralty Bay, Elson Lagoon, and the Barrier Islands, contain specific criteria that have been incorporated into stipulation language. Because of sensitive biological resources and/or subsistence concerns of Dease Inlet, Admiralty Bay, Elson Lagoon, and inland of the Barrier Islands, the standard(s) for exploration and development activities are set high with the burden of proof resting with the lessee to demonstrate to the authorized officer that granting an approval is warranted.	***K-3b Lease Stipulation/Best Management Practice – Kogru River, Dease Inlet, Admiralty Bay, Elson Lagoon, Peard Bay, Wainwright Inlet/Kuk River, and Kasegaluk Lagoon, and their associated Islands*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-3b would be a best management practice. Alternatives B-1 and C, and, to a lesser extent, Alternative B-2, would generally prohibit non-subsistence permanent infrastructure in these waters.			No comparable provision.
Objective: Protect fish and wildlife habitat, preserve air and water quality, and minimize impacts to traditional subsistence activities and historic travel routes on Dease Inlet, Admiralty Bay, and Elson Lagoon.	Objective: Protect fish and wildlife habitat (including, but not limited to, that for waterfowl and shorebirds, caribou insect-relief, and marine mammals), preserve air and water quality, and minimize impacts to subsistence activities and historic travel routes on the major coastal waterbodies.			
Requirement/Standard (Exploration): Oil and gas exploration operations (e.g., drilling, seismic exploration, and testing) are not allowed on Dease Inlet, Admiralty Bay, and Elson Lagoon (including natural and barrier islands), between May 15 and October 15 of each season. Requests for approval of any activities must be submitted in advance and must be accompanied by evidence and documentation that demonstrates to the satisfaction of the authorized office that the actions or activities meet all of the following criteria:	Requirement/Standard (Exploration): Oil and gas exploration operations (e.g., drilling, seismic exploration, and testing) are not allowed on the major coastal waterbodies and coastal islands between May 15 and October 15 of each season. Requests for approval of any activities must be submitted in advance and must be accompanied by evidence and documentation that demonstrates to the satisfaction of the authorized office that the actions or activities meet all of the following criteria:			
a. Exploration activities will not unreasonably conflict with traditional subsistence uses or significantly impact seasonally concentrated fish and wildlife resources.	a. Exploration activities will not unreasonably conflict with subsistence uses or significantly impact seasonally concentrated fish and wildlife resources.			
b. There is adequate spill response capability to effectively respond during periods of broken ice and/or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include improvements in blowout prevention technology, equipment and/or changes in operational procedures and "top-setting" of hydrocarbon-bearing zones.	b. There is adequate spill response capability to effectively respond during periods of broken ice and/or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include improvements in blowout prevention technology, equipment and/or changes in operational procedures and "top-setting" of hydrocarbon-bearing zones.			
c. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic will be conducted to minimize additional impacts or further compounding of "direct spill" related impacts on area resources and subsistence uses.	c. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic will be conducted to minimize additional impacts or further compounding of "direct spill" related impacts on area resources and subsistence uses.			
d. The location of exploration and related activities shall be sited	d. The location of exploration and related activities shall be sited so as to not			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
so as to not pose a hazard to navigation by the public using high-use traditional subsistence-related travel routes into and through Dease Inlet, Admiralty Bay and Elson Lagoon, as identified by the North Slope Borough, recognizing that marine and nearshore travel routes change over time, subject to shifting environmental conditions.	pose a hazard to navigation by the public using high-use subsistence-related travel routes into and through the major coastal waterbodies, as identified by the North Slope Borough, recognizing that marine and nearshore travel routes change over time, subject to shifting environmental conditions.			
e. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.	e. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.			
Requirement/Standard (Development): With the exception of linear features such as pipelines, no permanent oil and gas facilities are permitted on or under the water within 0.75 mile seaward of the shoreline (as measured from mean high tide) of Dease Inlet, Admiralty Bay, and Elson Lagoon or the natural islands (excluding Barrier Islands). Elsewhere, permanent facilities within Dease Inlet, Admiralty Bay, and Elson Lagoon will only be permitted on or under the water if they can meet all the following criteria:	Requirement/Standard (Development): With the exception of linear features such as pipelines, no permanent oil and gas facilities are permitted on or under the water within 0.75 mile seaward of the shoreline (as measured from mean high tide) of the major coastal waterbodies or the natural coastal islands (to the extent that the seaward subsurface is within NPR-A). Elsewhere, permanent facilities within the major coastal waterbodies will only be permitted on or under the water if they can meet all the following criteria:			
f. Design and construction of facilities shall minimize impacts to traditional subsistence uses, travel corridors, seasonally concentrated fish and wildlife resources.	f. Design and construction of facilities shall minimize impacts to subsistence uses, travel corridors, seasonally concentrated fish and wildlife resources.			
g. Daily operational activities, including use of support vehicles, watercraft, and aircraft traffic, alone or in combination with other past, present, and reasonably foreseeable activities, shall be conducted to minimize impacts to traditional subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.	g. Daily operational activities, including use of support vehicles, watercraft, and aircraft traffic, alone or in combination with other past, present, and reasonably foreseeable activities, shall be conducted to minimize impacts to subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.			
h. The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, bridges or causeways, shall be sited and constructed so as to not pose a hazard to navigation by the public using traditional high-use subsistence-related travel routes into and through Dease Inlet, Admiralty Bay and Elson Lagoon as identified by the North Slope Borough.	h. The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, bridges or causeways, shall be sited and constructed so as to not pose a hazard to navigation by the public using traditional high-use subsistence-related travel routes into and through the major coastal waterbodies as identified by the North Slope Borough.			
i. Demonstrated year-round oil spill response capability, including the capability of adequate response during periods of broken ice or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include seasonal drilling restrictions, improvements in blowout prevention technology, equipment	i. Demonstrated year-round oil spill response capability, including the capability of adequate response during periods of broken ice or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include seasonal drilling restrictions, improvements in blowout prevention technology, equipment and/or changes in operational procedures, and "top-setting" of hydrocarbon-bearing zones.			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
and/or changes in operational procedures, and "top-setting" of hydrocarbon-bearing zones. j. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic that add to impacts or further compound "direct spill" related impacts on area resources and subsistence uses. k. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.	j. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic that add to impacts or further compound "direct spill" related impacts on area resources and subsistence uses. k. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.			
K-4a Lease Stipulation - Goose Molting Area **Northeast** Objective: Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area. Requirement/Standard (General): Within the Goose Molting Area no permanent oil and gas facilities, except for pipelines will be allowed on the approximately 240,000 acres of lake buffers illustrated in lavender on Map 2-1. No alternative procedures will be considered. Prior to the permitting of a pipeline in the Goose Molting Area, a workshop will be convened to determine the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. In addition, only "in field" roads will be authorized as part of oil and gas field development. Requirement/Standard (Exploration): In goose molting habitat area exploratory drilling shall be limited to temporary facilities such as ice pads, ice roads, and ice airstrips, unless the lessee demonstrates that construction of permanent facilities (outside the identified Goose Molting Restricted Surface Occupancy Areas) such as gravel airstrips, storage pads, and connecting roads is environmentally preferable (Also see *Stipulation K-11* regarding allowable surface disturbance). In addition, the following standards will be followed for permitted activities: a. From June 15 through August 20 exploratory drilling and associated activities are prohibited. The intent of this rule is to restrict exploration drilling during the period when geese are present. b. Water extraction from any lake used by molting geese shall not	***K-4a Lease Stipulation/Best Management Practice – Goose Molting Area*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing, K-4a would be a best management practice. Objective: Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area. Requirement/Standard (General): Within the Goose Molting Area no permanent oil and gas facilities, except for pipelines, will be allowed within 1 mile of the shoreline of goose molting lakes. (See Map 2-3K for the current location of these 1-mile setback areas.) No waiver, exception, or modification will be considered. Prior to the permitting of a pipeline in the Goose Molting Area, a workshop will be convened to determine the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to Federal, state, and North Slope Borough representatives. In addition, only "in field" roads will be authorized as part of oil and gas field development. Requirement/Standard (Exploration): In goose molting habitat area exploratory drilling shall be limited to temporary facilities such as ice pads, ice roads, and ice airstrips, unless the lessee demonstrates that construction of permanent facilities (outside the identified Goose Molting Restricted Surface Occupancy Areas) such as gravel airstrips, storage pads, and connecting roads is environmentally preferable. (Also see *Stipulation K-11* regarding allowable surface disturbance). In addition, the following standards will be followed for permitted activities: a. From June 15 through August 20 exploratory drilling and associated activities are prohibited. The intent of this rule is to restrict exploration drilling during the period when geese are present. b. Water extraction from any lake used by molting geese shall not alter			***K-4a Lease Stipulation – Goose Molting Area*** Objective: Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area. Requirement/ Standard: Roads will be designed to minimize impacts to molting geese. In general, roads shall be designed to avoid areas within 0.25 mile of molting geese lakes.

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
alter hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.	hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.			
c. Oil and gas exploration activities will avoid alteration (e.g., damage or disturbance of soils, vegetation, or surface hydrology) of critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss), as identified by the authorized officer in consultation with the USFWS.	c. Oil and gas exploration activities will avoid alteration (e.g., damage or disturbance of soils, vegetation, or surface hydrology) of critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss), as identified by the authorized officer in consultation with the USFWS.			
Requirement/Standard (Development): In Goose Molting Area, the following standards will be followed for permitted activities:	Requirement/Standard (Development): In the Goose Molting Area, the following standards will be followed for permitted activities:			
a. Within the Goose Molting Area from June 15 through August 20, all off-pad activities and major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended (see also Lease Stipulation K-5-d), unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb molting geese during the period when geese are present.	a. Within the Goose Molting Area from June 15 through August 20, all off-pad activities and major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended (see also Lease Stipulation K-5-d), unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb molting geese during the period when geese are present.			
b. Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.	b. Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.			
c. Oil and gas activities will avoid altering (i.e., damage or disturbance of soils, vegetation, or surface hydrology) critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss) and salt marsh habitats.	c. Oil and gas activities will avoid altering (i.e., damage or disturbance of soils, vegetation, or surface hydrology) critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss) and salt marsh habitats.			
d. Permanent oil and gas facilities (including gravel roads, pads, and airstrips, but excluding pipelines) and material sites will be sited outside the identified buffers and restricted surface occupancy areas. Additional limits on development footprint apply; (also see Lease Stipulation K-11.)	d. Permanent oil and gas facilities (including gravel roads, pads, and airstrips, but excluding pipelines) and material sites will be sited outside the identified buffers and restricted surface occupancy areas. Additional limits on development footprint apply; (also see Lease Stipulation K-11.)			
e. Between June 15 and August, 20 within the Goose Molting Area, oil and gas facilities shall incorporate features (e.g., temporary fences, siting/orientation) that screen/shield human activity from view of any Goose Molting Area lake, as identified by the authorized officer in consultation with appropriate federal, State, and North Slope Borough regulatory	e. Between June 15 and August, 20 within the Goose Molting Area, oil and gas facilities shall incorporate features (e.g., temporary fences, siting/orientation) that screen/shield human activity from view of any Goose Molting Area lake, as identified by the authorized officer in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies.			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
and resource agencies.				
f. Strategies to minimize ground traffic shall be implemented from June 15 through August 20. These strategies may include limiting trips, use of convoys, different vehicle types, etc. to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.	f. Strategies to minimize ground traffic shall be implemented from June 15 through August 20. These strategies may include limiting trips, use of convoys, different vehicle types, etc. to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.			
g. Within the Goose Molting Area aircraft use (including fixed wing and helicopter) shall be restricted from June 15 through August 20 unless doing so endangers human life or violates safe flying practices. Restrictions may include: (1) limiting flights to two round-trips/week, and (2) limiting flights to corridors established by the BLM after discussions with appropriate federal, State, and North Slope Borough regulatory and resource agencies. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. Note: This site-specific lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and required operating procedures. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.	g. Within the Goose Molting Area aircraft use (including fixed wing and helicopter) shall be restricted from June 15 through August 20 unless doing so endangers human life or violates safe flying practices. Restrictions may include: (1) limiting flights to two round-trips/week, and (2) limiting flights to corridors established by the BLM after discussions with appropriate federal, State, and North Slope Borough regulatory and resource agencies. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. **Note:** This site-specific lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.			
h. Any permit for development issued under this IAP/EIS will include a requirement for the lessee to conduct monitoring studies necessary to adequately determine consequences of development and any need for change to mitigations. Monitoring studies will be site- and development-specific within a set of over-arching guidelines developed by the BLM after conferring with appropriate federal, State, North Slope Borough agencies. The study(s) will include the construction period and will continue for a minimum of 3 years after construction has been completed and production has begun. The monitoring studies will be a continuation of evaluating the effectiveness of the K-4 Lease Stipulation requirements in meeting the objective of K-4 and determine if any changes to the lease stipulation or any project specific mitigation(s) are	h. Any permit for development issued under this IAP/EIS will include a requirement for the lessee to conduct monitoring studies necessary to adequately determine consequences of development and any need for change to mitigations. Monitoring studies will be site- and development-specific within a set of over-arching guidelines developed by the BLM after conferring with appropriate federal, State, North Slope Borough agencies. The study(ies) will include the construction period and will continue for a minimum of 3 years after construction has been completed and production has begun. The monitoring studies will be a continuation of evaluating the effectiveness of Stipulation K-4a's requirements in meeting the objective of K-4 and determine if any changes to the lease stipulation or any project specific mitigation(s) are necessary. If changes are determined to be necessary, the BLM, with the lessee and/or their representative, will conduct an assessment of the feasibility of altering development operation (e.g., reduced human activity, visibility barriers,			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
necessary. If changes are determined to be necessary, the BLM, with the lessee and/or their representative, will conduct an assessment of the feasibility of altering development operation (e.g., reduced human activity, visibility barriers, noise abatement). Any changes determined necessary will be implemented prior to authorization of any new construction.	noise abatement). Any changes determined necessary will be implemented prior to authorization of any new construction.			
K-4b Required Operating Procedure – Brant Survey Area **Northwest** Objective: Minimize the loss or alteration of habitat for, or disturbance of, nesting and brood rearing brant in the Brant Survey Area. Requirement/Standard: a. Aerial surveys for brant nesting colonies and brood-rearing areas shall be conducted for a minimum of 2 years before authorization of construction of permanent facilities. At a minimum, the survey area shall include the proposed development site(s) (i.e., the footprint) and the surrounding 0.5-mile area. These surveys shall be conducted following accepted BLM protocol. b. Development may be prohibited or activities curtailed within 0.5 mile of all identified brant nesting colonies and brood-rearing areas identified during the 2-year survey.	***K-4b Best Management Practice – Brant Survey Area*** Objective: Minimize the loss or alteration of habitat for, or disturbance of, nesting and brood rearing brant in the Brant Survey Area. Requirement/Standard: a. Aerial surveys for brant nesting colonies and brood-rearing areas shall be conducted for a minimum of 2 years before authorization of construction of permanent facilities. At a minimum, the survey area shall include the proposed development site(s) (i.e., the footprint) and the surrounding 0.5-mile area. These surveys shall be conducted following accepted BLM protocol. b. Development may be prohibited or activities curtailed within 0.5 mile of all identified brant nesting colonies and brood-rearing areas identified during the 2-year survey. *(Same text as in Northwest NPR-A 2004 Record of Decision)*			
K-5a Lease Stipulation - Teshekpuk Lake Caribou Habitat Area **Northeast** Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect-relief, and migration. Requirement/Standard: In the Teshekpuk Lake Caribou Habitat Area the following standards will be applied to permitted activities: a. Before authorization of construction of permanent facilities (limited as they may be by restricted surface occupancy areas established in other lease stipulations), the lessee shall design and implement and report a study of caribou movement unless an acceptable study(s) specific to the Teshekpuk Caribou Herd has been completed within the last 10 years. The study shall include a minimum of 4 years of current data on the Teshekpuk Caribou Herd movements and the study design shall be approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough wildlife	***K-5a Lease Stipulation/Best Management Practice –Teshekpuk Lake Caribou Habitat Area*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-5a would be a best management practice. Under Alternatives B-1, B-2 and C the Teshekpuk Lake Caribou Habitat Area encompasses those lands designated as such in the Northeast NPR-A Supplemental IAP Record of Decision and the Caribou Study Area in the Northwest NPR-A IAP Record of Decision as well as additional lands south of the area as defined in Alternative A. Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect-relief, and migration. Requirement/Standard: In the Teshekpuk Lake Caribou Habitat Area the following standards will be applied to permitted activities: a. Before authorization of construction of permanent facilities (limited as they may be by restricted surface occupancy areas established in other lease stipulations), the lessee shall design and implement and report a study of caribou movement unless an acceptable study(s) specific to the Teshekpuk			***K-5a Lease Stipulation– Teshekpuk Lake Caribou Habitat Area*** Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area (see Map 2-4K) that are essential for all season use, including calving and rearing, insect-relief, and migration. Requirement/

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
and resource agencies. The study should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Teshekpuk Lake Caribou Habitat Area. Study data may be gathered concurrently with other activities as approved by the authorized officer and in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. A final report of the study results will be prepared and submitted. Prior to the permitting of a pipeline in the Teshekpuk Lake Caribou Habitat Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife (specifically the Teshekpuk Caribou Herd) and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. All of these modifications will increase protection for caribou and other wildlife that utilize the Teshekpuk Lake Caribou Habitat Area during all seasons. b. Within the Teshekpuk Lake Caribou Habitat Area, lessees shall orient linear corridors when laying out oil field developments to the extent practicable, to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities. c. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required by the authorized officer, after consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, in the Teshekpuk Lake Caribou Habitat Area where pipelines potentially impede caribou movement. d. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb caribou during calving and insect-relief periods. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. The lessee shall submit with the development proposal a "stop work" plan that considers this and any other mitigation related to caribou	Caribou Herd has been completed within the last 10 years. The study shall include a minimum of four years of current data on the Teshekpuk Caribou Herd movements and the study design shall be approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. The study should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Teshekpuk Lake Caribou Habitat Area. Study data may be gathered concurrently with other activities as approved by the authorized officer and in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. A final report of the study results will be prepared and submitted. Prior to the permitting of a pipeline in the Teshekpuk Lake Caribou Habitat Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife (specifically the Teshekpuk Caribou Herd) and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. All of these modifications will increase protection for caribou and other wildlife that utilize the Teshekpuk Lake Caribou Habitat Area during all seasons. b. Within the Teshekpuk Lake Caribou Habitat Area, lessees shall orient linear corridors when laying out oil and gas field developments to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities. c. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required by the authorized officer, after consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, in the Teshekpuk Lake Caribou Habitat Area where pipelines potentially impede caribou movement. d. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb caribou during calving and insect-relief periods. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. The lessee shall submit with the development proposal a "stop work" plan that considers this and any other mitigation related to caribou early arrival. The intent of this latter requirement is to provide flexibility to adapt to changing climate conditions that may occur during the life of fields in the region.			Standard: Same as Alternatives B-1 through C.

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>early arrival. The intent of this latter requirement is to provide flexibility to adapt to changing climate conditions that may occur during the life of fields in the region.
e. The following ground and air traffic restrictions shall apply to permanent oil and gas-related roads in the areas and time periods indicated:
1. Within the Teshekpuk Lake Caribou Habitat Area, from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within 0.5 mile of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, etc., to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
2. The lessee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these observations, traffic will be stopped temporarily to allow a crossing by 10 or more caribou. Sections of road will be evacuated whenever an attempted crossing by a large number of caribou appears to be imminent. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
3. Major equipment, materials, and supplies to be used at oil and gas work sites in the Teshekpuk Lake Caribou Habitat Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period.
4. Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20 unless doing so endangers human life or violates safe flying practices. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter by authorized users of the [Northeast NPR-A] planning area, including oil and gas lessees, from May 20 through August 20 within the Teshekpuk Lake Caribou Habitat Area, except for emergency purposes. The lessee shall submit with</td><td colspan="3">e. The following ground and air traffic restrictions shall apply in the areas and time periods indicated. Ground traffic restrictions apply to permanent oil and gas-related roads:
1. Within the Teshekpuk Lake Caribou Habitat Area, from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within 0.5 mile of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, etc., to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
2. The lessee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these observations, traffic will be stopped:
a. temporarily to allow a crossing by 10 or more caribou. Sections of road will be evacuated whenever an attempted crossing by a large number of caribou appears to be imminent. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation.
b. by direction of the authorized officer throughout a defined area for up to four weeks to prevent displacement of calving caribou.
The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
3. Major equipment, materials, and supplies to be used at oil and gas work sites in the Teshekpuk Lake Caribou Habitat Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period.
4. Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20 unless doing so endangers human life or violates safe flying practices. Authorized users of the NPR-A may be restricted from using aircraft larger than a Twin Otter, and limited to an average of one fixed-wing aircraft takeoff and landing per day per airstrip, except for emergency purposes. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter by authorized users of the NPR-A, including oil and gas lessees, from</td><td></td></tr>
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ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2 Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and required operating procedures. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.
5. Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through June 20 unless doing so endangers human life or violates safe flying practices. Restrictions may include limiting fixed-wing aircraft takeoffs and landings by authorized users of the [Northeast NPR-A] planning area to an average of one round-trip flight per day from May 20 through June 20, at aircraft facilities within the Teshekpuk Lake Caribou Habitat Areas. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
6. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless doing so endangers human life or violates safe flying practices. Caribou wintering ranges will be defined annually by the authorized officer in consultation with the Alaska Department of Fish and Game. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and required operating procedures. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.</td><td colspan="3">May 20 through August 20 within the Teshekpuk Lake Caribou Habitat Area, except for emergency purposes. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.
5. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless doing so endangers human life or violates safe flying practices. Caribou wintering ranges will be defined annually by the authorized officer in consultation with the Alaska Department of Fish and Game. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.</td><td></td></tr>
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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td><i>K-5b Required Operating Procedure – Caribou Study Area</i>
Northwest
<u>Objective</u>: None stated.
<u>Requirement/Standard</u>: Before authorization of construction of permanent facilities, the lessee shall design and implement a study of caribou movement, especially during the insect season. The study would include a minimum of 3 years of current data on caribou movements. The study design shall be approved by the authorized officer and should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Caribou Study Area. Study data may be gathered concurrently with other activities.</td><td colspan="4"><i>K-5b Best Management Practice – Caribou Study Area</i>
NOTE: This applies only to Alternative D. Alternatives B1-, B-2, and C are incorporated into K-5a Stipulation, above.
<u>Objective</u>: Minimize disturbance and hindrance of caribou, or alteration of caribou movements in the Caribou Study Area.
<u>Requirement/ Standard</u>: Before authorization of construction of permanent facilities, the lessee shall design and implement a study of caribou movement, especially during the insect season. The study would include a minimum of 3 years of current data on caribou movements. The study design shall be approved by the authorized officer and should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Caribou Study Area. Study data may be gathered concurrently with other activities.</td></tr>
<tr><td><i>K-6 Stipulation - Coastal Area</i>
Northeast
<u>Objective</u>: Minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; to prevent contamination of marine waters; loss of important bird habitat; alteration or disturbance of shoreline marshes; and impacts to subsistence resources activities.
<u>Requirement/Standard</u>: In the Coastal Area, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located at least 0.75 mile inland from the coastline to the extent practicable. Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within 0.75 mile inland of the coastline, the practicality of locating the facility at previously occupied sites such as Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning-Line sites, shall be considered. Use of existing sites within 0.75 mile of the coastline shall also be acceptable where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the Nuiqsut Whaling Captains' Association, and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.</td><td colspan="4"><i>K-6 Lease Stipulation – Coastal Area (Alternatives B-1, C, and D)</i>
Note: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-6 would be a best management practice.
<u>Objective</u>: Minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; to protect the summer shoreline habitat for polar bears, walrus, and seals; to prevent contamination of marine waters; loss of important bird habitat; alteration or disturbance of shoreline marshes; and impacts to subsistence resources activities.
<u>Requirement/Standard</u>: No permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located in the Coastal Area, which includes all barrier and offshore islands within NPR-A and a coastal strip extending 0.75 mile inland from the coast. (In Alternatives B-1 and C, the coastal strip between the Kogru River and Tangent Point would extend 1 mile inland, instead of 0.75 mile, in order to protect molting geese habitat.) Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within 0.75 mile inland of the coastline (Alternatives B-1 and C, 1 mile inland between Kogru River and Tangent Point), the practicality of locating the facility at previously occupied sites such as Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning-Line sites, shall be considered. Use of existing sites within 0.75 mile of the coastline (Alternatives B-1 and C, 1 mile inland between Kogru River and Tangent Point) shall also be acceptable where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the Nuiqsut Whaling Captains' Association, and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope. In a case in which the BLM authorizes a permanent oil and gas facility within the Coastal Area, the lessee/permittee shall develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.</td></tr>
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ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

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Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr>
<td>Northwest
<u>Objective</u>: Same.
<u>Requirement/Standard</u>: In the Coastal Area, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines established to support exploration and development activities shall be located at least 0.75 mile inland from the coastline to the extent practicable. Where, as a result of technological limitations, economics, logistics, or other factors, a facility must be located within 0.75 mile inland of the coastline, the practicality of locating the facility at previously occupied sites, such as the former Cape Simpson, Peard Bay, or Wainwright Distant Early Warning-Line sites, shall be considered. Use of existing sites within 0.75 mile of the coastline shall also be acceptable where it is demonstrated that use of such sites will reduce impacts to shorelines or otherwise be environmentally preferable. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users.</td>
<td colspan="4"><i>K-6 Lease Stipulation – Coastal Area (Alternative B-2 only)</i>
<u>Objective</u>: Protect coastal waters and their value as fish and wildlife habitat (including, but not limited to, that for waterfowl, shorebirds, and marine mammals), minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources activities.
<u>Requirement/Standard</u>:
a. Exploratory well drill pads, production well drill pads, or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the Reserve and the mainland, or in inland areas within one mile of the coast. (Note: This would include the entirety the Kasegaluk Lagoon and Peard Bay Special Areas.) Other facilities necessary for oil and gas production within NPR-A that necessarily must be within this area (e.g., barge landing, seawater treatment plant, or spill response staging and storage areas) would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. Lessees/permittees shall consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and Distant Early Warning-Line sites. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the North Slope Borough, and local whaling captains associations to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope. In a case in which the BLM authorizes a permanent oil and gas facility within the Coastal Area, the lessee/permittee shall develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.
b. Marine vessels used as part of a BLM-authorized activity shall maintain a 1-mile buffer from the shore when transiting past an aggregation of seals (primarily spotted seals) using a terrestrial haulout unless doing so would endanger human life or violate safe boating practices. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast except when necessary for the safe operation of the vessel.
c. Marine vessels used as part of a BLM-authorized activity shall maintain a 0.5-mile buffer from shore when transiting past an aggregation of walrus using a terrestrial haulout.</td>
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ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
K-7 Lease Stipulation - Colville River Special Area **Northeast** Objective: Prevent or minimize loss of raptor foraging habitat (also see Lease Stipulation K-1; Rivers Area). Requirement/Standard for Facilities: If necessary to construct permanent facilities within the Colville River Special Area, all reasonable and practicable efforts shall be made to locate permanent facilities as far from raptor nests as feasible. Additionally, within 15 miles of raptor nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative. Of particular concern are ponds, lakes, wetlands, and riparian habitats. **Note:** On a case-by-case basis, and in consultation with appropriate federal and State regulatory and resource agencies, essential pipeline and road crossings will be permitted through these areas where no other feasible or prudent options are available.	***K-7 Lease Stipulation – Colville River Special Area*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-7 would be a best management practice Objective: Prevent or minimize loss of raptor foraging habitat (also see Lease Stipulation K-1; Rivers Area). Requirement/Standard for Facilities: If necessary to construct permanent facilities within the Colville River Special Area, all reasonable and practicable efforts shall be made to locate permanent facilities as far from raptor nests as feasible. Additionally, within 15 miles of raptor nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal. Of particular concern are ponds, lakes, wetlands, and riparian habitats. **Note:** On a case-by-case basis, and in consultation with appropriate federal and State regulatory and resource agencies, essential pipeline and road crossings will be permitted through the Colville River Special Area where no other feasible or prudent options are available.			No comparable provision.
K-7 Lease Stipulation - Colville River Special Area **Northwest** Objective: Prevent or minimize loss of raptor foraging habitat. Requirement/Standard: If necessary to construct permanent facilities within the Colville River Special Area, all reasonable and practicable efforts shall be made to locate permanent facilities as far from raptor nests as feasible. Within 15 mile of raptor nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative. Of particular concern are ponds, lakes, wetlands, and riparian habitats. **Note:** On a case-by case basis, and in consultation with appropriate federal and State regulatory and resource agencies, essential pipeline and road crossings will be permitted through these areas where no other options are available.				
Colville River Special Area Management Plan-Protection 2 Objective: Prevent or minimize loss of arctic peregrine falcon foraging habitat in the Colville River Special Area. Requirement/Standard: To minimize the direct loss of arctic peregrine falcon foraging habitat in the Colville River Special Area the following measures apply: If necessary to construct permanent facilities within the Colville River Special Area, all	*(Colville River Special Area Management Plan Protection 2 would not be changed.)*			*(Colville River Special Area Management Plan Protection 2 is deleted.)*

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
reasonable and practicable efforts shall be made to locate permanent facilities as far from arctic peregrine falcon nests as feasible. Within 15 miles of arctic peregrine falcon nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal or it is determined that there is no feasible or prudent alternative. Of particular concern are ponds, lakes, wetlands, and riparian habitats. **Note:** On a case-by-case basis, and in consultation with appropriate federal and State regulatory and resource agencies, essential pipeline and road crossings will be permitted through these areas where no other feasible or prudent options are available.				
K-8a Lease Stipulation - Pik Dunes Objective: Retain unique qualities of the Pik Dunes, including geologic and scenic uniqueness, insect-relief habitat for caribou, and habitat for several uncommon plant species. Requirement/Standard: Surface structures, except approximately perpendicular pipeline crossings and ice pads, are prohibited within the Pik Dunes.	***K-8a Lease Stipulation – Pik Dunes*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-8a would be a best management practice. Objective: Retain unique qualities of the Pik Dunes, including geologic and scenic uniqueness, insect-relief habitat for caribou, and habitat for several uncommon plant species. Requirement/Standard: Surface structures, except approximately perpendicular pipeline crossings and ice pads, are prohibited within the Pik Dunes. *(Same text as in Northeast NPR-A 2008 Record of Decision)*			
K-8b Lease Stipulation–Kasegaluk Lagoon Special Area Objective: Protect the habitat of the fish, waterfowl, and terrestrial and marine wildlife resources of Kasegaluk Lagoon, and protect traditional subsistence uses and public access to and through Kasegaluk Lagoon for current and future generations of North Slope residents. Requirement/Standard: Within the Kasegaluk Lagoon Special Area, oil and gas leasing is approved subject to the decision to defer the implementation of oil and gas leasing in the "leasing deferral area." When leasing is implemented, no permanent oil and gas facilities are permitted within the boundary of the Special Area. Geophysical (seismic) exploration is authorized subject to the terms and conditions provided in other applicable required operating procedures. No restrictions are imposed on traditional subsistence activities and access for subsistence purposes.	***K-8b Best Management Practice – Kasegaluk Lagoon Special Area*** **Note: This applies only to Alternatives B-1 and C**. There would be no comparable provision for Alternatives B-2 and D. This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-8b would be a best management practice Objective: Protect the habitat of the fish, waterfowl, and terrestrial and marine wildlife resources of Kasegaluk Lagoon, and protect subsistence uses and public access to and through Kasegaluk Lagoon for current and future generations of North Slope residents. Requirement/Standard: No permanent oil and gas surface facilities are permitted in the Kasegaluk Lagoon and an area one mile inland from the lagoon.			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
K-9 Lease Stipulation – Caribou Movement Corridor **Northeast** Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and rearing, insect-relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake to approximately 6 miles eastward towards the Kogru Inlet [River] and the area adjacent to the northwest corner of Teshekpuk Lake. Requirement/Standard: Within the Caribou Movement Corridors, no permanent oil and gas facilities, except for pipelines, will be allowed on the approximately 60,500 (approximately 50,800 acres east of Teshekpuk Lake, and approximately 9,700 acres northwest of Teshekpuk Lake) illustrated on Map 2-1K. Prior to the permitting of a pipeline in the Caribou Movement Corridors, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. **Note:** In addition to the general lease stipulations and required operating procedures, site-specific lease stipulations, i.e., K-3, K-4, K-5, and K-11 will also apply. **Northwest** No comparable provision.	***K-9 Lease Stipulation/Best Management Practice – Teshekpuk Lake Caribou Movement Corridors*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-9 would be a best management practice. Alternatives B-1 and B-2 would generally prohibit non-subsistence permanent infrastructure in all, or nearly all, of these areas. Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and rearing, insect-relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake eastward to the Kogru River and the area between Teshekpuk Lake and an unnamed lake in T16–17 N, R8 W, U.M. Requirement/Standard: Within the Caribou Movement Corridors, no permanent oil and gas facilities, except for pipelines or, in the case of Alternative B-2 only other infrastructure associated with offshore oil and gas exploration and production, will be allowed on the approximately 62,100 (approximately 50,800 acres east of Teshekpuk Lake, and approximately 11,300 acres northwest of Teshekpuk Lake) illustrated on Map 2-3K. Prior to the permitting of permanent oil and gas infrastructure in the Caribou Movement Corridors, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives.			No comparable provision.
K-10 Lease Stipulation – Southern Caribou Calving Area **Northeast** Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and post calving, and insect-relief) in the area south/southeast of Teshekpuk Lake: Requirement/Standard: Within the Southern Caribou Calving Area, no permanent oil and gas facilities, except pipelines, would be allowed on the approximately 240,000 acres illustrated on Map 2-1K. Prior to the permitting of a pipeline in the Southern Caribou Calving Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. **Note:** In addition to the general stipulations and required operating procedures, site-specific Stipulations K-4, K-5, K-6, and K-11 would also apply.	***K-10 Lease Stipulation/Best Management Practice – Teshekpuk Lake Southern Caribou Calving Area*** **Note**: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-10 would be a best management practice. Alternatives B-1 and B-2 would generally prohibit non-subsistence permanent infrastructure in all, or nearly all, of this area. Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and post calving, and insect-relief) in the area south/southeast of Teshekpuk Lake. Requirement/Standard: Within the Southern Caribou Calving Area, no permanent oil and gas facilities, except pipelines or, in the case of Alternative B-2 only other infrastructure associated with offshore oil and gas exploration and production, will be allowed on the approximately 240,000 acres illustrated on Map 2-3K. Prior to the permitting of permanent oil and gas infrastructure in the Southern Caribou Calving Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to			No comparable provision.

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
Northwest No comparable provision.	federal, State, and North Slope Borough representatives. **Note:** In addition to the general stipulations and best management practices, site-specific *Stipulations K-4, K-5, K-6, and K-11* would also apply.			
K-11 Lease Stipulation: Lease Tracts A-G **Northeast** Objective: To protect key surface resources and subsistence resources/activities resulting from permanent oil and gas development and associated activities. Requirement Standard: Permanent surface disturbance resulting from oil and gas activities is limited to 300 acres within the following described lease tracts (Map 2-1K); this does not include surface disturbance activities from pipeline construction. Existing gravel pads within these tracts would not count against the 300-acre limit. A pipeline will be considered after a workshop is convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. (No alternative procedures will be approved). (Acreages are based on GIS calculations and are approximate): A. Total Acreage: approximately 52,700: • 26,500 acres = Restricted surface occupancy for permanent oil and gas facilities excluding pipelines (the 23,350 acres includes 5,605 acres of overlap with the Coastal area restrictions). • 26,200 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures. The total new development footprint cannot exceed 300 acres (0.6% of total acreage). B. Total Acreage: approximately 55,000: • 38,200 acres = Restricted surface occupancy for permanent oil and gas facilities, excluding pipelines (the 33,478 acres includes 5,131 acres of overlap with the Coastal area restrictions). • 16,800 acres = Area open to development subject to general and site-specific lease stipulations and required operating procedures. The total new development footprint cannot exceed 300 acres (0.5% of total acreage).	No comparable provision. Under Alternatives B-1 and B-2, leasing is unavailable in the area covered by tracts A-G.		***K-11 Lease Stipulation – Lease Tracts A-G*** Objective: To protect key surface resources and subsistence resources/activities resulting from permanent oil and gas development and associated activities. Requirement Standard: Permanent surface disturbance resulting from oil and gas activities is limited to 300 acres within the following described lease tracts (Maps 2-3K and 2-4K); this does not include surface disturbance activities from pipeline construction. Existing gravel pads within these tracts would not count against the 300-acre limit. A pipeline will be considered for development of one or more of these tracts after a workshop is convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but need not be limited to Federal, state, and North Slope Borough representatives. (No alternative procedures will be approved). (Acreages are based on GIS calculations and are approximate): A. Total Acreage: approximately 52,700: The total new development footprint cannot exceed 300 acres (0.6% of total acreage). B. Total Acreage: approximately 55,000: The total new development footprint cannot exceed 300 acres (0.5% of total acreage). C. Total Acreage: approximately 46,100: The total new development footprint cannot exceed 300 acres (0.7% of total acreage). D. Total Acreage: approximately 54,500: The total new development footprint cannot exceed 300 acres (0.6% of total acreage). E. Total Acreage: approximately 56,500: The total new development footprint cannot	

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
C. Total Acreage: approximately 46,100: • 32,500 acres = Restricted surface occupancy for permanent oil and gas facilities, excluding pipelines. • 3,600 acres = Area open to development subject to general and site-specific lease stipulations and required operating procedures. The total new development footprint cannot exceed 300 acres (0.7% of total acreage). D. Total Acreage: approximately 54,500: • 46,900 acres = Restricted surface occupancy for permanent oil and gas facilities excluding pipelines. • 7,700 acres = Area open to development subject to general and site-specific lease stipulations and required operating procedures. The total new development footprint cannot exceed 300 acres (0.6% of total acreage). E. Total Acreage: approximately 56,500: • 32,200 acres = Restricted surface occupancy for permanent oil and gas facilities, excluding pipelines. • 24,300 acres = Area open to development subject to general and site-specific lease stipulations and required operating procedures. The total new development footprint cannot exceed 300 acres (0.5% of total acreage). F. Total Acreage: approximately 57,100: • 43,200 acres = Restricted surface occupancy for permanent oil and gas facilities, excluding pipelines. • 4,900 acres = Restricted area open to development subject to the results of 3-year study requirement to determine appropriate placement of permanent facility(s) (Map 2-1). • 9,000 acres = Area open to development subject to general and site specific lease stipulations and required operating procedures. The total new development footprint cannot exceed 300 acres (0.5% of total acreage). G. Total Acreage: approximately 56,800: • 48,700 acres = Restricted surface occupancy for permanent oil and gas facilities excluding pipelines. • 300 acres = Restricted area open to development subject to the results of 3-year study requirement to determine appropriate placement of permanent facility(s) (Map 2-1K). • 7,800 acres = Area open to development subject to general and site specific lease stipulations and required operating			exceed 300 acres (0.5% of total acreage). F. Total Acreage: approximately 57,100: The total new development footprint cannot exceed 300 acres (0.5% of total acreage). G. Total Acreage: approximately 56,800: The total new development footprint cannot exceed 300 acres (0.5% of total acreage).	

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
procedures. The total new development footprint cannot exceed 300 acres (0.5% of total acreage). **Northwest** No comparable provision.				
No comparable provision.	***K-12 Lease Stipulation/Best Management Practice – Western Arctic Herd Habitat Area*** **Note:** This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternative, K-12 would be a best management practice. In each of the alternatives, this stipulation applies to the configuration of the Utukok River Uplands Special Area proposed for the respective alternative. Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through the Utukok River Uplands Special Area that are essential for all season use, including calving and rearing, insect-relief, and migration. Requirement/Standard: In the Utukok River Uplands Special Area the following standards will be applied to permitted activities: a. Before authorization of construction of permanent facilities, the lessee shall design and implement and report a study of caribou movement unless an acceptable study(s) specific to the Western Arctic Herd has been completed within the last 10 years. The study shall include a minimum of four years of current data on the Western Arctic Herd's movements and the study design shall be approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies and the Western Arctic Caribou Herd Working Group. The study should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Utukok River Uplands Special Area. Study data may be gathered concurrently with other activities as approved by the authorized officer and in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. A final report of the study results will be prepared and submitted. Prior to the permitting of a pipeline in the Utukok River Uplands Special Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife (specifically the Western Arctic Herd) and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. All of these modifications will increase protection for caribou and other wildlife that utilize the Utukok River Uplands Special Area during all seasons. b. Within the Utukok River Uplands Special Area, lessees shall orient linear corridors when laying out oil and gas field developments to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities. c. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required by the authorized officer, after consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, in the Utukok River Uplands Special Area where pipelines potentially impede caribou movement. d. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline			

ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td></td><td colspan="4">and pad construction, but not drilling from existing production pads) shall be suspended within Utukok River Uplands Special Area from May 20 through August 20, unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb caribou during calving and insect-relief periods. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. The lessee shall submit with the development proposal a “stop work” plan that considers this and any other mitigation related to caribou early arrival. The intent of this latter requirement is to provide flexibility to adapt to changing climate conditions that may occur during the life of fields in the region.
e. The following ground and air traffic restrictions shall apply to permanent oil and gas-related roads in the areas and time periods indicated:
1. Within the Utukok River Uplands Special Area, from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within 0.5 mile of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, etc., to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
2. The lessee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these observations, traffic will be stopped:
a. Temporarily to allow a crossing by 10 or more caribou. Sections of road will be evacuated whenever an attempted crossing by a large number of caribou appears to be imminent. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation.
b. By direction of the authorized officer throughout a defined area for up to four weeks to prevent displacement of calving caribou.
The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
3. Major equipment, materials, and supplies to be used at oil and gas work sites in the Utukok River Uplands Special Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period.
4. Within the Utukok River Uplands Special Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20 unless doing so endangers human life or violates safe flying practices. Authorized users of the NPR-A may be restricted from using aircraft larger than a Twin Otter, and limited to an average of one fixed-wing aircraft takeoff and landing per day per airstrip, except for emergency purposes. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter by authorized users of the NPR-A, including oil and gas lessees, from May 20 through August 20 within the Utukok River Uplands Special Area, except for emergency purposes. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will</td></tr>
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ADDITIONAL PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td></td><td colspan="4">be restricted to the minimum necessary to collect such data.
5. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Utukok River Uplands Special Area from May 20 through August 20, unless doing so endangers human life or violates safe flying practices. Caribou wintering ranges will be defined annually by the authorized officer in consultation with the Alaska Department of Fish and Game. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.</td></tr>
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SUMMER VEHICLE TUNDRA ACCESS

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>*L-1 Required Operating Procedure*
Northeast
Objective: Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; protect cultural and paleontological resources; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities.
Requirement/Standard: On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in Required Operating Procedure C-2a. Permission for such use would only be granted after an applicant has:
a. Submitted studies satisfactory to the authorized officer of the impacts on soils and vegetation of the specific low-ground-pressure vehicles to be used. These studies should reflect use of such vehicles under conditions similar to those of the route proposed for use and should demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.
b. Submitted surveys satisfactory to the authorized officer of subsistence uses of the area as well as of the soils, vegetation, hydrology, wildlife and fish (and their habitats), paleontological and archaeological resources, and other resources as required by the authorized officer.</td><td colspan="4">*L-1 Best Management Practice*
Objective: Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; protect cultural and paleontological resources; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities.
Requirement/Standard: On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in Best management Practice C-2a. Permission for such use would only be granted after an applicant has:
a. Submitted studies satisfactory to the authorized officer of the impacts on soils and vegetation of the specific low-ground-pressure vehicles to be used. These studies should reflect use of such vehicles under conditions similar to those of the route proposed for use and should demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.
b. Submitted surveys satisfactory to the authorized officer of subsistence uses of the area as well as of the soils, vegetation, hydrology, wildlife and fish (and their habitats), paleontological and archaeological resources, and other resources as required by the authorized officer.</td></tr>
</table>

SUMMER VEHICLE TUNDRA ACCESS

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
c. Designed and/or modified the use proposal to minimize impacts to the authorized officer's satisfaction. Design steps to achieve the objectives and based upon the studies and surveys may include, but not be limited to, timing restrictions (generally it is considered inadvisable to conduct tundra travel prior to August 1 to protect ground-nesting birds), shifting of work to winter, rerouting, and not proceeding when certain wildlife are present or subsistence activities are occurring. At the discretion of the authorized officer, the plan for summer tundra vehicle access may be included as part of the spill prevention and response contingency plan required by 40 CFR 112 (Oil Pollution Act) and Required Operating Procedure A-4. **Northwest** No comparable provision.	c. Designed and/or modified the use proposal to minimize impacts to the authorized officer's satisfaction. Design steps to achieve the objectives and based upon the studies and surveys may include, but not be limited to, timing restrictions (generally it is considered inadvisable to conduct tundra travel prior to August 1 to protect ground-nesting birds), shifting of work to winter, rerouting, and not proceeding when certain wildlife are present or subsistence activities are occurring. At the discretion of the authorized officer, the plan for summer tundra vehicle access may be included as part of the spill prevention and response contingency plan required by 40 CFR 112 (Oil Pollution Act) and Required Operating Procedure A-4. *(Same text as in Northeast NPR-A 2008 Record of Decision)*			

GENERAL WILDLIFE AND HABITAT PROTECTION

Alternative A	Alternative B-1	Alternative B-2 Preferred Alternative	Alternative C	Alternative D
No comparable provision.	***M-1 Best Management Practice*** NOTE: **This best management practice is only applicable to Alternative B-2**. There would be no comparable provision for any of the other alternatives. Objective: Minimize disturbance and hindrance of wildlife, or alteration of wildlife movements through the NPR-A. Requirement/Standard: Chasing wildlife with ground vehicles is prohibited. Particular attention will be given to avoid disturbing caribou.			
No comparable provision.	***M-2 Best Management Practice*** NOTE: **This best management practice is applicable only to Alternative B-2**. There would be no comparable provision for any of the other alternatives. Objective: Prevent the introduction, or spread, of non-native, invasive plant species in the NPR-A. Requirement/Standard: Certify that all equipment and vehicles (intended for use either off or on roads) are weed-free prior to transporting them into the NPR-A. Monitor annually along roads for non-native invasive species, and initiate effective weed control measures upon evidence of their introduction. Prior to operations in the NPR-A, submit a plan for the BLM's approval, detailing the methods for cleaning equipment and vehicles, monitoring for weeds and weed control.			

GENERAL WILDLIFE AND HABITAT PROTECTION

<table>
<tr><th>Alternative A</th><th>Alternative B-1</th><th>Alternative B-2
Preferred Alternative</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>No comparable provision.</td><td colspan="4">M-3 Best Management Practice
NOTE: This best management practice is applicable only to Alternative B-2. There would be no comparable provision for any of the other alternatives.
Objective: Minimize loss of populations of, and habitat for, plant species designated as Sensitive by the BLM in Alaska.
Requirement/Standard: If a development is proposed in an area that provides potential habitat for a BLM Sensitive Plant Species, the development proponent would conduct surveys at appropriate times of the summer season and in appropriate habitats for the Sensitive Plant Species that might occur there. The results of these surveys will be submitted to the BLM with the application for development.</td></tr>
<tr><td>No comparable provision.</td><td colspan="4">M-4 Best Management Practice
NOTE: This best management practice is applicable only to Alternative B-2. There would be no comparable provision for any of the other alternatives.
Objective: Minimize loss of individuals of, and habitat for, mammalian species designated as Sensitive by the BLM in Alaska.
Requirement/Standard: If a development is proposed in an area that provides potential habitat for the Alaska tiny shrew, the development proponent would conduct surveys at appropriate times of the year and in appropriate habitats in an effort to detect the presence of the shrew. The results of these surveys will be submitted to BLM with the application for development.</td></tr>
</table>

2.8 Comparison of the Consequences of Each Alternative

Table 2-4 summarizes the likely effects of oil and gas activities on resources and uses in the NPR-A for each alternative. It also summarizes cumulative effects for these resources and uses. Information contained in these tables is derived from more detailed discussions in Chapter 4 (Environmental Consequences).

Table 2-4. Summary and comparison of effects on resources by alternative

EFFECTS ON AIR QUALITY

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Exploration, development, and production activities are expected to cause increases in the concentrations of criteria pollutants, hazardous air pollutants (HAPs), volatile organic compounds (VOCs) and greenhouse gases (GHGs). This could result in a decrease in visibility and an increase in atmospheric deposition. Air pollutant emissions are projected to be lower than Alternatives C and D due to less federally owned subsurface being available for oil and gas leasing and higher than Alternatives B-1 and B-2 due to more federally owned subsurface being available for oil and gas leasing.	Exploration, development, and production activities are expected to cause increases in the concentrations of criteria pollutants, HAPs, VOCs and GHGs. This could result in a decrease in visibility and an increase in atmospheric deposition. Air pollutant emissions are projected to be the lowest compared to the other alternatives due to substantially less federally owned subsurface being available for oil and gas leasing compared to Alternatives C and D and slightly less compared to Alternatives B-2 and A.	Exploration, development, and production activities are expected to cause increases in the concentrations of criteria pollutants, HAPs, VOCs and GHGs. This could result in a decrease in visibility and an increase in atmospheric deposition. Air pollutant emissions are projected to be higher than Alternative B-1 due to more federally owned subsurface land being available for oil and gas leasing and lower than Alternatives A, C, and D due to substantially less federally owned subsurface being available for oil and gas leasing.	Exploration, development, and production activities are expected to cause increases in the concentrations of criteria pollutants, HAPs, VOCs and GHGs. This could result in a decrease in visibility and an increase in atmospheric deposition. Air pollutant emissions are projected to be higher than Alternatives A, B-1, and B-2 due to more federally owned subsurface land being available for oil and gas leasing and lower than Alternative D due to substantially less federally owned subsurface being available for oil and gas leasing.	Exploration, development, and production activities are expected to cause increases in the concentrations of criteria pollutants, HAPs, VOCs and GHGs. This could result in a decrease in visibility and an increase in atmospheric deposition. Air pollutant emissions are projected to be the highest of all alternatives due to more federally owned subsurface being available for oil and gas leasing.
Cumulative Effects: The cumulative effects of all projects affecting the North Slope of Alaska in the past have caused some deterioration in air quality. Improvements in air-pollution-control technology would help reduce emissions from historic levels, which may be offset somewhat by increasing production. Arctic haze will continue to be of concern on the North Slope, due primarily to air pollutant emissions originating in northern Europe and Asia. In the future, each proposed individual facility will be required to disclose its potential air quality impacts thorough site-specific NEPA analyses, and demonstrate compliance with applicable local, state, tribal and Federal air quality requirements. As facilities are shut down, they would no longer contribute to North Slope air emissions. Particulate matter emissions would also be reduced at sites that are re-vegetated. The impacts of oil and gas development in the Chukchi and Beaufort Seas and construction of roads to support their development would result in increased emissions of criteria pollutants, HAPs, VOCs, and GHGs. The extent of the impact would depend upon the size of operation, duration of activities, distance offshore, and mitigation measures imposed by the regulatory agency. Potential oil and gas development east (upwind) of NPR-A would likely result in increases in air pollution depending upon the magnitude of the production operation and distance from NPR-A.				

EFFECTS ON PALEONTOLOGICAL RESOURCES

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
The potential for impacts to paleontological resources from exploration activities is low because exploration occurs during the winter months when the surface of the landscape is protected by snow, the ground is frozen and pads, roads, and airstrips are constructed of snow and ice. The potential from non-oil and gas activities to cause adverse impacts is minimal. Activities associated with development of production wells and associated infrastructure, pose the greatest potential impact to paleontological resources. The activity of utmost concern is excavation for mineral material and trenching for buried pipelines. A catastrophic oil or gas well blowout would probably destroy or render scientifically valueless any nearby paleontological resource site. Abandonment and reclamation of infrastructure would, under normal circumstances, have limited if any impact on the resource. Under this alternative, approximately 40 million cubic yards of mineral material could be excavated from material sites and 3.2 million cubic yards from pipeline trenching. In addition, approximately 9,902 acres could be impacted by by infrastructure surface disturbance associated with oil and gas activities.	The potential for impacts to paleontological resources from exploration activities is low because exploration occurs during the winter months when the surface of the landscape is protected by snow, the ground is frozen and pads, roads, and airstrips are constructed of snow and ice. The potential from non-oil and gas activities to cause adverse impacts is minimal. Activities associated with development of production wells and associated infrastructure, pose the greatest potential impact to paleontological resources. The activity of utmost concern is excavation for mineral material and trenching for buried pipelines. A catastrophic oil or gas well blowout would probably destroy or render scientifically valueless any nearby paleontological resource site. Abandonment and reclamation of infrastructure would, under normal circumstances, have limited if any impact on the resource. Under Alternative B-1, as much as 29 million cubic yards of mineral material could be excavated from material sites and 3.3 million cubic yards from pipeline trenching. In addition, approximately 7,505 acres could be impacted by by infrastructure surface disturbance associated with oil and gas activities.	The potential for impacts to paleontological resources from exploration activities is low because exploration occurs during the winter months when the surface of the landscape is protected by snow, the ground is frozen and pads, roads, and airstrips are constructed of snow and ice. The potential from non-oil and gas activities to cause adverse impacts is minimal. Activities associated with development of production wells and associated infrastructure, pose the greatest potential impact to paleontological resources. The activity of utmost concern is excavation for mineral material and trenching for buried pipelines. A catastrophic oil or gas well blowout would probably destroy or render scientifically valueless any nearby paleontological resource site. Abandonment and reclamation of infrastructure would, under normal circumstances, have limited if any impact on the resource. Under Alternative B-2, as much as 31 million cubic yards of mineral material could be excavated from material sites and 3.3 million cubic yards from pipeline trenching. In addition, about 8,402 acres could be impacted by by infrastructure surface disturbance associated with oil and gas activities.	The potential for impacts to paleontological resources from exploration activities is low because exploration occurs during the winter months when the surface of the landscape is protected by snow, the ground is frozen and pads, roads, and airstrips are constructed of snow and ice. The potential from non-oil and gas activities to cause adverse impacts is minimal. Activities associated with development of production wells and associated infrastructure, pose the greatest potential impact to paleontological resources. The activity of utmost concern is excavation for mineral material and trenching for buried pipelines. A catastrophic oil or gas well blowout would probably destroy or render scientifically valueless any nearby paleontological resource site. Abandonment and reclamation of infrastructure would, under normal circumstances, have limited if any impact on the resource. Under Alternative C, as much as 52 million cubic yards of mineral material could be excavated from material sites and 8.3 million cubic yards from pipeline trenching. In addition, approximately 15,311 acres could be impacted by by infrastructure surface disturbance associated with oil and gas activities.	The potential for impacts to paleontological resources from exploration activities is low because exploration occurs during the winter months when the surface of the landscape is protected by snow, the ground is frozen and pads, roads, and airstrips are constructed of snow and ice. The potential from non-oil and gas activities to cause adverse impacts is minimal. Activities associated with development of production wells and associated infrastructure, pose the greatest potential impact to paleontological resources. The activity of utmost concern is excavation for mineral material and trenching for buried pipelines. A catastrophic oil or gas well blowout would probably destroy or render scientifically valueless any nearby paleontological resource site. Abandonment and reclamation of infrastructure would, under normal circumstances, have limited if any impact on the resource. Under this alternative, as much as 59 million cubic yards of mineral material could be excavated from material sites and 8.5 million cubic yards from pipeline trenching. In addition, approximately 16,329 acres could be impacted by by infrastructure surface disturbance associated with activities.

EFFECTS ON PALEONTOLOGICAL RESOURCES

<table>
<tr><th>Alternative A
(No-action Alternative)</th><th>Alternative B-1</th><th>Alternative B-2
(Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="5">Cumulative Effects: The most important factor in regard to the probability of adversely affecting paleontological sites is the geographic location in which a given development activity will take place. Within the areas of highest probability for economically recoverable oil and gas in the NPR-A there are few known locales of paleontological material and the accumulated paleontological data does not provide any insight regarding the potential for the presence of undiscovered sites. Most paleontological resource locales are buried and generally not vulnerable to the effects of incidental surface disturbance. Beyond incidental surface disturbing activities is the excavation and trenching associated with oil and gas development. The excavation of material sources will impact paleontological remains if they are present within the boundaries of the pit; a hit or miss situation. Trenching for pipelines will create transects across the landscape and has the greatest potential for impact to the resource. Therefore the more area that is open to oil and gas related activities, particularly excavation and trenching, the greater the potential for impact to paleontological resources and the probable increase of cumulative adverse effects. However, as has been mentioned previously, due to regulations and awareness, over the last 30 years of oil and gas exploration and development activities on the North Slope there have been few instances where paleontological material was impacted and data lost.</td></tr>
</table>

EFFECTS ON SOIL RESOURCES

<table>
<tr><th>Alternative A
(No-action Alternative)</th><th>Alternative B-1</th><th>Alternative B-2
(Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>Work will continue under this alternative with both long-term and short-term impacts. The level of impact is between that of Alternatives B-2 and C.</td><td>The least impacts to soils would occur under this Alternative. The total short-term impact would be less than 0.05% of the area of the coastal plain. Long-term impacts are expected to be 0.01% of the area of the coastal plain.</td><td>This alternative will impact slightly more to soils area than under Alternative B-1. The total short-term impact would still be be less than 0.05% of the area of the coastal plain and the long-term impacts are expected to be 0.01% of the area of the coastal plain.</td><td>This alternative will impact less than twice the area of Alternative B-1 and approximately 90% of the area of Alternative D. Long-term impact would be midway between that of Alternative A and D.</td><td>The greatest impact to soils would occur under this alternative but the total short-term impact is still less than 0.1% of the land on the coastal plain. Long-term impacts are expected to be 0.03% of the area of the coastal plain.</td></tr>
<tr><td colspan="5">Cumulative Effects: All Alternatives will increase the impact to soil. The short-term impacts are expected to diminish after a few years and the long-term impact will be about 3% of the original footprint regardless of the alternative. The long-term impacts are not substantially different given the size of the planning area (0.01 to 0.03% of the area) but these effects are expected to continue for 100 years or more.</td></tr>
</table>

EFFECTS ON WATER RESOURCES AND WATER QUALITY

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Non-oil and gas activities would have negligible to minor effects on water resources and water quality. It is estimated that a total of 1,490 acres of moderate to high impacts to water quality from thermokarst erosion due to seismic activities could result. Construction of 196 wells, 7,074 acres of gravel placement for production pads, in-field roads and runways, and 40 gravel pits would all contribute to short and long-term impacts to water quality by introducing turbidity changes to waterbodies, dust effects; losses of water and possible water quality changes from water withdrawals; erosion and sedimentation; impounded water at road crossings; alteration of drainage patterns; and impacts on water quality from oil, produced water and seawater spills into waterbodies.	Non-oil and gas activities would have negligible to minor effects on water resources and water quality. It is estimated that a total of 1,670 acres of moderate to high impacts to water quality from thermokarst erosion due to seismic activities could result. Construction of 128 wells, 5,037 acres of gravel placement for production pads, in-field roads and runways, and 29 gravel pits would all contribute to short and long-term impacts to water quality by introducing turbidity changes to waterbodies, dust effects; losses of water and possible water quality changes from water withdrawals; erosion and sedimentation; impounded water at road crossings; alteration of drainage patterns; and impacts on water quality from oil, produced water and seawater spills into waterbodies. Impacts to water resources and water quality are expected to be less than under Alternative A.	Non-oil and gas activities would have negligible to minor effects on water resources and water quality. It is estimated that a total of 1,670 acres of moderate to high impacts to water quality from thermokarst erosion due to seismic activities could result. Construction of 152 wells, 5,614 acres of gravel placement for production pads, in-field roads and runways, and 31 gravel pits would all contribute to short and long-term impacts to water quality by introducing turbidity changes to waterbodies, dust effects; losses of water and possible water quality changes from water withdrawals; erosion and sedimentation; impounded water at road crossings; alteration of drainage patterns; and impacts on water quality from oil, produced water and seawater spills into waterbodies. Impacts to water resources and water quality are expected to be less than under Alternative A.	Non-oil and gas activities would have negligible to minor effects on water resources and water quality. It is estimated that a total of 2,452 acres of moderate to high impacts to water quality from thermokarst erosion due to seismic activities could result. Construction of 236wells, 9,387 acres of gravel placement for production pads, in-field roads and runways, and 51 gravel pits would all contribute to short and long-term impacts to water quality by introducing turbidity changes to waterbodies, dust effects; losses of water and possible water quality changes from water withdrawals; erosion and sedimentation; impounded water at road crossings; alteration of drainage patterns; and impacts on water quality from oil, produced water and seawater spills into waterbodies. Impacts to water resources and water quality are expected to be greater than under Alternatives A, B-1, and B-2.	Non-oil and gas activities would have negligible to minor effects on water resources and water quality. It is estimated that a total of 2,658 acres of moderate to high impacts to water quality from thermokarst erosion due to seismic activities could result. Construction of 256 wells, 10,438 acres of gravel placement for production pads, in-field roads and runways, and 55 gravel pits would all contribute to short and long-term impacts to water quality by introducing turbidity changes to waterbodies, dust effects; losses of water and possible water quality changes from water withdrawals; erosion and sedimentation; impounded water at road crossings; alteration of drainage patterns; and impacts on water quality from oil, produced water and seawater spills into waterbodies. Impacts to water resources and water quality are expected to be greater than all other alternatives.

Cumulative Effects: Approximately 2,500 acres of direct surface disturbance from non-oil and gas activities have impacted waterbodies and drainage patterns. Oil and gas activities have caused approximately 18,400 acres of direct impacts and another 18,400 acres of indirect impacts. Through 2011, over 9,500 acres of gravel pads and roads were constructed in association with oil-field development on the North Slope. Inadequate design and placement of structures, culverts, or bridges have caused impoundments, streambank erosion, scour and sedimentation at stream crossings. This has altered natural sediment transport and deposition, creating scour holes or channel bars. Several spills have occurred on the North Slope, but their effects have been minor and have not accumulated. A large amount of debris was left on the North Slope from exploration and military activities from 1940 to 1970 that impacted water quality, but clean-up efforts since the 1970s have removed some of the remaining debris.

Impacts from future activities other than those associated with oil and gas development would be minor. The amount of area that would be disturbed by new development is projected to increase by at least 2% annually for the next few decades. These impacts are additive to the impacts to waterbodies that have accumulated in the past and persist today, but in the context of the NPR-A and North Slope, these cumulative impacts would be small. Gravel mining for oil and gas development would account for a total of 10,600 acres by the year 2100. The majority of the impacts would result from oil and gas development activities, with construction of roads, permanent drill pads, stream-crossing structures, and water use from lakes during the winter months being the major contributors. The overall cumulative impact to water resources on the North Slope and in the NPR-A would probably be small in magnitude and most impacts would be local in nature due to the concentration of promising oil and gas plays in specific areas. There could be synergistic effects on water resources and quality that would take place from Beaufort and Chukchi Sea development. These developments could make other oil fields elsewhere in the NPR-A economically feasible, or require processing and transportation of offshore oil and gas, therefore resulting in additional water quality impacts.

EFFECTS ON VEGETATION

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Non-oil and gas activities would have negligible to minor effects on vegetation and would affect no more than 200 acres of the NPR-A per year. Oil exploration would disturb vegetation on a maximum of 18,460 acres from 2-D seismic work and approximately 519,590 acres from 3-D surveys, for a total of 538,050 acres disturbed. About 25% of the disturbance from 2-D or 3-D seismic trails would be moderate to high, short-term impacts, with a greater percentage at that level for camp-move trails; there would be long-term impacts on about 1,490 acres. Construction of ice pads would occur on 1,176 acres over a 30-year period. Another 325,508 acres would be impacted by construction of ice roads. The construction of exploration well cellars would result in permanent, minor vegetation destruction and alteration on 0.3 acres. Development activities would cause the loss of vegetation on 7,524 acres and the alteration of plant species composition on 29,301 acres. Material sites would affect 1,415 acres and pipelines would have long-term impacts on 1,413 acres. Development activities would affect a total of 39,203 acres. These impacts would be permanent if gravel pads remained after production ended, although some plant species would be able to grow on the pads. Development impacts	Non-oil and gas activities would have negligible to minor effects on vegetation and would affect no more than 200 acres of the NPR-A per year. Impacts from seismic surveys would affect about 8% more acres than under Alternative A for a total of 581,397 acres with 1,670 acres of long-term disturbance. Construction of ice pads would occur on 768 acres over a 30-year period. Another 231,995 acres would be impacted by construction of ice roads. Development activities would cause the loss of vegetation on 4,872 acres and the alteration of plant species composition on 20,734 acres. Material sites would affect 1,007 acres and pipelines would have long-term impacts on 1,460 acres. Development activities would affect a total of 28,239 acres. These impacts would be permanent if gravel pads remained after production ended, although some plant species would be able to grow on the pads. Development impacts would affect about 0.12% of the NPR-A and would not be likely to adversely affect any plant species or plant communities. Overall, less vegetation would be impacted than under Alternative A, and impacts would still be minor, provided rare plant populations were avoided through careful siting at the facilities-approval stage.	Non-oil and gas activities would have negligible to minor effects on vegetation and would affect no more than 200 acres of the NPR-A per year. Impacts from seismic surveys would affect about 8% more acres than under Alternative A for a total of 581,397 acres with 1,670 acres of long-term disturbance. Construction of ice pads would occur on 912 acres over a 30-year period. Another 249,246 acres would be impacted by construction of ice roads. Development activities would cause the loss of vegetation on 5,336 acres and the alteration of plant species composition on 23,596 acres. Material sites would affect 1,125 acres and pipelines would have long-term impacts on 1,651 acres. Development activities would affect a total of 31,998 acres. These impacts would be permanent if gravel pads remained after production ended, although some plant species would be able to grow on the pads. Development impacts would affect about 0.14% of the NPR-A and would not be likely to adversely affect any plant species or plant communities. Overall, less vegetation would be impacted than under Alternative A, and impacts would still be minor, provided rare plant populations were avoided through careful siting at the facilities-approval stage.	Non-oil and gas activities would have negligible to minor effects on vegetation and would affect no more than 200 acres of the NPR-A per year. Impacts from seismic surveys would affect about 34% more acres than under Alternative A for a total of 718,894 acres with 2,453 acres of long-term disturbance. Construction of ice pads would impact vegetation on 1,464 acres over a 30-year period. Another 422,810 acres would be impacted by construction of ice roads. Development activities would cause the loss of vegetation on 9,650 acres and the alteration of plant species composition on 40,493 acres. Material sites would affect 1,941 acres and pipelines would have long-term impacts on 3,720 acres. Development activities would affect a total of 55,804 acres. These impacts would be permanent if gravel pads remained after production ended, although some plant species would be able to grow on the pads. Development impacts would affect about 0.24% of the total NPR-A and would not be likely to adversely affect any plant species or plant communities. Overall, a greater amount of vegetation would be impacted than under Alternatives A, B-1 or B-2, but impacts would still be minor, provided rare plant populations were avoided through careful siting at the facilities-approval stage.	Non-oil and gas activities would have negligible to minor effects on vegetation and would affect no more than 200 acres of the NPR-A per year. Impacts from seismic surveys would affect about 46% more acres than under Alternative A for a total of 786,603 acres with 2,658 acres of long-term disturbance. Construction of ice pads would occur on 1,536 acres over a 30-year period. Construction of ice roads would impact vegetation on 456,683 acres over 30 years. Development activities would cause the loss of vegetation on 10,439 acres and the alteration of plant species composition on 43,574 acres. Material sites would affect 2,088 acres and pipelines would have long-term impacts on 3,802 acres. Development activities would affect a total of 59,903 acres. These impacts would be permanent if gravel pads remained after production ended, although some plant species would be able to grow on the pads. Development impacts would affect about 0.26% of the total NPR-A and would not be likely to adversely affect any plant species or plant communities. Overall, a greater amount of vegetation would be impacted than under any of the other alternatives. Impacts would be minor, provided rare plant populations were avoided through careful siting at the facilities-approval stage. Increased

EFFECTS ON VEGETATION

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
would affect about 0.17% of the total NPR-A and would not be likely to adversely affect any plant species or plant communities. Overall, impacts would be minor, provided rare plant populations were avoided through careful siting at the facilities-approval stage.				development in the area around Teshekpuk Lake could disproportionately affect wet vegetation classes, whereas development in the southwest portion of the NPR-A could disproportionately affect dwarf shrub, tussock tundra and sparsely vegetated communities.
Cumulative Effects: Approximately 2,500 acres of direct impacts and 4,630 acres of indirect impacts to vegetation from non-oil and gas activities persist across the North Slope today and will continue into the future. Those numbers would increase to approximately 4,300 and 7,960 acres, respectively, throughout this century. By 2012, oil and gas activities will have caused approximately 18,153 acres of direct impacts and about 56,000 acres of indirect impacts to vegetation that will persist long term. For the most part, all of the above impacts would be additive. Although the increase in the amount of area disturbed by oil and gas development has slowed dramatically in recent years, it is estimated that an additional 3,750 acres could be covered by gravel and 750 acres impacted by gravel mines east of the NPR-A between 2012 and 2100. Approximately 27,000 acres would be indirectly affected by dust, changes in hydrology, and thermokarst. Additionally, oil/gas development in the Chukchi and Beaufort offshores, construction of a road and pipeline(s) between Umiat and the Dalton Highway, construction of a commercial gas pipeline and unconventional oil and gas development east of the NPR-A could cause direct impacts on up to 12,550 acres and indirect impacts on 37,585 acres. Development in the NPR-A could directly impact approximately 9,902, 7,505, 8,402, 15,311, and 16,329 acres, and indirectly impact 29,301, 20,734, 23,596, 39,062, and 43,574 acres of vegetation for Alternatives A through D, respectively. Long-term impacts to vegetation from seismic surveys in the NPR-A would occur on 1,490 to 2,658 acres. Total, long-term, direct and indirect impacts to vegetation from exploration and development combined would occur on 0.12% (Alternative B-1) to 0.26% (Alternative D) of the NPR-A. All these future impacts to vegetation both inside and outside of the NPR-A are additive to the impacts to vegetation that have accumulated in the past and persist today, but in the context of the entire North Slope, these cumulative impacts would be relatively small. Based on direct (55,599 acres) and indirect (172,119 acres) impacts that would persist throughout this century, combined direct and indirect impacts to vegetation from activities on the North Slope (231,026 acres, assuming Alternative D for the NPR-A) would affect approximately 0.45% of the entire North Slope or 0.55% of the North Slope east of the Arctic National Wildlife Refuge. Some potential scenarios for development in the Chukchi and Beaufort seas could create a synergism resulting in even greater development in the NPR-A, if the offshore development resulted in onshore facilities that made additional NPR-A development economically feasible. The above estimates of total, long-term impacts do not take into account the distribution of the vegetation that would be impacted on the North Slope. If facilities were constructed in an area containing a population of a plant species designated as sensitive by the BLM in Alaska, by definition rare, loss of one or more plant populations could be a significant cumulative impact to that species. Nine sensitive plant species are known to occur in the NPR-A, and another 12 species are known to occur elsewhere on the North Slope, but have not been documented in the NPR-A. Climate change could drive additional alteration of plant community composition, increasing deciduous shrubs, and sedges and grasses, at the expense of lichens and mosses. This could have a synergistic effect along with alteration due to indirect effects of development.				

EFFECTS ON WETLANDS AND FLOODPLAINS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Seismic (camp move trails): 1,490 acres Construction: 9,902 acres Altered plant communities: 29,301 acres	Seismic (camp move trails): 1,670 acres Construction: 7,505 acres Altered plant communities: 20,734 acres	Seismic (camp move trails): 1,670 acres Construction: 8,402 acres Altered plant communities: 23,596 acres	Seismic (camp move trails): 2,453 acres Construction: 15,311 acres Altered plant communities: 40,493 acres	Seismic (camp move trails): 2,658 acres Construction: 16,329 acres Altered plant communities: 43,574 acres
Non-oil and gas activities would have negligible to minor effects on wetlands and floodplains. There would be no substantial, long-term impacts to wetlands and floodplains from seismic lines, but camp move trails could result in long-term impacts to wetlands. Construction of gravel pads roads, and airstrips, from excavation of material sites and burial of gas pipelines, and construction of vertical support members could result in long-term impacts to wetlands. Altered plant communities affected by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns could result. These impacts would be permanent if gravel pads remained after production ended.	Non-oil and gas activities would have negligible to minor effects on wetlands and floodplains. There would be no substantial, long-term impacts to wetlands and floodplains from seismic lines, but camp move trails could result in long-term impacts to wetlands. Construction of gravel pads roads, and airstrips, from excavation of material sites and burial of gas pipelines, and construction of vertical support members could result in long-term impacts to wetlands. Altered plant communities affected by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns could result. Impacts to wetlands and floodplains are expected to be less than under Alternative A.	Non-oil and gas activities would have negligible to minor effects on wetlands and floodplains. There would be no substantial, long-term impacts to wetlands and floodplains from seismic lines, but camp move trails could result in long-term impacts to wetlands. Construction of gravel pads roads, and airstrips, from excavation of material sites and burial of gas pipelines, and construction of vertical support members could result in long-term impacts to wetlands. Altered plant communities affected by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns could result. Impacts to wetlands and floodplains are expected to be less than under Alternative A.	Non-oil and gas activities would have negligible to minor effects on wetlands and floodplains. There would be no substantial, long-term impacts to wetlands and floodplains from seismic lines, but camp move trails could result in long-term impacts to wetlands. Construction of gravel pads roads, and airstrips, from excavation of material sites and burial of gas pipelines, and construction of vertical support members could result in long-term impacts to wetlands. Altered plant communities affected by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns could result. Impacts to wetlands and floodplains are expected to be greater than under Alternatives A, B-1, and B-2.	Non-oil and gas activities would have negligible to minor effects on wetlands and floodplains. There would be no substantial, long-term impacts to wetlands and floodplains from seismic lines, but camp move trails could result in long-term impacts to wetlands. Construction of gravel pads roads, and airstrips, from excavation of material sites and burial of gas pipelines, and construction of vertical support members could result in long-term impacts to wetlands. Altered plant communities affected by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns could result. Impacts to wetlands and floodplains are expected to be greater than the other alternatives.

Cumulative Effects: Approximately 2,500 acres of direct impacts to wetlands from non-oil and gas activities persist today with a projected increase to 4,300 acres through the end of this century. Past oil and gas activities have directly and indirectly impacted approximately 39,300 acres of wetlands and floodplains. Assuming Alternative D is adopted, an additional 59,903 acres of direct and indirect impacts may occur from future exploration and development. Impacts to wetlands include exploration activities and construction of gravel pads, gravel roads, gravel airstrips, gravel staging areas, excavation of material sites, oil pipelines, and possible gas pipelines. The duration of the impacts would range from short term (< 1 to 5 years) if the vegetation was lightly disturbed up to several decades or longer if the vegetation was covered by gravel, removed, or permafrost was thawed creating thermokarst. Additionally, oil/gas development in the Chukchi and Beaufort offshores, construction of a road and pipeline(s) between Umiat and the Dalton Highway, construction of a commercial gas pipeline and unconventional oil and gas development east of the NPR-A could affect up to 50,100 acres of direct and indirect impacts. Additional NPR-A development may become feasible as a result of these future developments. Impacts to floodplains could occur from river channel crossings by pipelines and roads, which could alter the natural drainage and stream channel and destroy vegetation where bridge pilings or vertical support members were required for the crossing. These impacts would be additive with impacts from other developments occurring on the North Slope.

EFFECTS ON FISH

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Non-oil and gas activities that are part of BLM operations or authorizations would have negligible effects on fish. The potential effects of oil and gas activities on fish include acoustic disturbance, injury at water-use intakes, altered water quality, physical habitat changes (water quantity, flow patterns, and geomorphology), point and non-point source pollution, increased turbidity and sedimentation, and barriers to fish movements. Required operating procedures and lease stipulations would mitigate these effects to the extent that most impacts on fish would be localized and short term. A measurable change at the population level is not likely. Based on NPR-A lands available for leasing under Alternative A, 17,800 miles of potential stream habitat, 1,642,000 acres of potential lake habitat, and the entire coastline (1,200 miles) except Kasegaluk Lagoon would be susceptible to impacts that could affect fish.	Non-oil and gas activities that are part of BLM operations or authorizations would have negligible effects on fish. The potential effects of oil and gas activities on fish include acoustic disturbance, injury at water-use intakes, altered water quality, physical habitat changes (water quantity, flow patterns, and geomorphology), point and non-point source pollution, increased turbidity and sedimentation, and barriers to fish movements. Best management practices and lease stipulations would mitigate these effects to the extent that most impacts on fish would be localized and short term. A measurable change at the population level is not likely. Based on NPR-A lands available for leasing under Alternative B-1, 16,300 miles of potential stream habitat, 1,009,500 acres of potential lake habitat, and <100 miles of coastline would be susceptible to impacts that could affect fish.	Non-oil and gas activities that are part of BLM operations or authorizations would have negligible effects on fish. The potential effects of oil and gas activities on fish include acoustic disturbance, injury at water-use intakes, altered water quality, physical habitat changes (water quantity, flow patterns, and geomorphology), point and non-point source pollution, increased turbidity and sedimentation, and barriers to fish movements. Best management practices and lease stipulations would mitigate these effects to the extent that most impacts on fish would be localized and short term. A measurable change at the population level is not likely. Based on NPR-A lands available for leasing under Alternative B-2, 17,300 miles of potential stream habitat, 1,001,500 acres of potential lake habitat, and <100 miles of coastline would be susceptible to impacts that could affect fish.	Non-oil and gas activities that are part of BLM operations or authorizations would have negligible effects on fish. The potential effects of oil and gas activities on fish include acoustic disturbance, injury at water-use intakes, altered water quality, physical habitat changes (water quantity, flow patterns, and geomorphology), point and non-point source pollution, increased turbidity and sedimentation, and barriers to fish movements. Best management practices and lease stipulations would mitigate these effects to the extent that most impacts on fish would be localized and short term. A measurable change at the population level is not likely. Based on NPR-A lands available for leasing under Alternative C, 25,600 miles of potential stream habitat, 1,651,400 acres of potential lake habitat, and 600 miles of coastline would be susceptible to impacts that could affect fish.	Non-oil and gas activities that are part of BLM operations or authorizations would have negligible effects on fish. The potential effects of oil and gas activities on fish include acoustic disturbance, injury at water-use intakes, altered water quality, physical habitat changes (water quantity, flow patterns, and geomorphology), point and non-point source pollution, increased turbidity and sedimentation, and barriers to fish movements. Best management practices and lease stipulations would mitigate these effects to the extent that most impacts on fish would be localized and short term. A measurable change at the population level is not likely. Based on NPR-A lands available for leasing under Alternative C, 34,100 miles of potential stream habitat, 1,879,400 acres of potential lake habitat, and 1,200 miles of coastline would be susceptible to impacts that could affect fish. Additionally, due to the absence of protective provisions that are in the other alternatives, fish in Teshekpuk Lake and the major coastal waterbodies would be much more prone to impacts. Fish would be at the greatest risk of a population level effect under Alternative D.

EFFECTS ON FISH

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Cumulative Effects: Effects on fish from non-oil and gas activities that are part of BLM operations or authorizations would not be expected to accumulate. The extent of anticipated cumulative effects on fish from oil and gas activities in the NPR-A and surrounding areas would vary depending upon the alternative selected under this IAP/EIS. Onshore permanent infrastructure (roads, pads, and pipelines), gravel mining, and causeways (or other similar structures) are the elements that are likely to contribute to cumulative effects on fish. The most cumulative impacts on fish from onshore permanent infrastructure would be probable under Alternative D (3,940 miles of roads and pipelines). The estimated incidence of infrastructure impacts that could accumulate would be 42% less under Alternative A (2,281 miles), 52% less under Alternative B-1 (1,893 miles), 48% less under Alternative B-2 (2,058 miles), and 3% less under Alternative C (3,820 miles). Cumulative impacts attributable to gravel mining would also be expected to be greatest under Alternative D (≤55 gravel pits). The magnitude of those impacts would be an estimated 27% less for Alternative A (≤40 gravel pits), 47% less for Alternative B-1 (≤29 gravel pits), 44% less for Alternative B-2 (≤31 gravel pits), and 5% less for Alternative C (≤52 gravel pits). However, whether or not the net impact from gravel mining would be negative or positive for fish would depend on site-specific management decisions. The potential for the most additive impacts to occur from causeways, or other similar structures that extend into coastal waters, would be under Alternative D, as well. Alternative D would permit development anywhere along the NPR-A coastline (1,200 miles). A similar degree of risk would occur under Alternative A (1,200 miles), which would allow development along the entire coast except for Kasegaluk Lagoon. Comparatively, causeways could only be built along approximately 50% of the coastline under Alternative C (600 miles) and <10% of the coastline under Alternatives B-1 and B-2 (<100 miles). Considering all aspects of oil and gas activities, cumulative effects on fish would be the greatest under Alternative D and the least under Alternative B-1.				

EFFECTS ON BIRDS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Non-oil and gas activities, seismic work, and drilling of exploration wells would have minor effects on bird populations. Impacts to birds from oil and gas activities would be localized and short-term, and would be unlikely to occur at the population level. Permanent and temporary loss of habitat due to construction and operation of infrastructure could cause diminished breeding opportunities and success for some birds. Disturbance by vehicle, aircraft, and pedestrian traffic could temporarily or permanently displace birds from preferred habitats and affect individual birds' survival or reproduction. Bird mortality could also result from collisions with vehicles or structures, increased predation (due to elevated levels of predators near	Non-oil and gas activities, seismic work, and drilling of exploration wells would have minor effects on bird populations. The types of impacts to birds from oil and gas development and abandonment would be similar to those discussed under Alternative A. Effects of oil and gas development activities would occur over slightly less of the NPR-A than under Alternative A and there would be substantially less oil and gas development, and consequently less impacts to birds than in Alternatives C and D. Important coastal areas would not be available for leasing and more lands than in other alternatives would be in Special Areas designated for bird protection. Consequently a lower number of birds would potentially be disturbed and,	Non-oil and gas activities, seismic work, and drilling of exploration wells would have minor effects on bird populations. The types of impacts to birds from oil and gas development and abandonment would be similar to those discussed under Alternative A. Effects of oil and gas development activities would occur over less of the NPR-A than under Alternative A and there would be substantially less oil and gas development, and consequently less impacts to birds than in Alternatives C and D. The vast majority of coastal areas would be unavailable for leasing and some very important bird habitat would prohibit any new non-subsistence infrastructure to be built. Consequently a lower number of birds would potentially be	Non-oil and gas activities, seismic work, and drilling of exploration wells would have minor effects on bird populations. The types of impacts to birds from oil and gas development and abandonment would be similar to those discussed under Alternative A. The potential for habitat loss and alteration to affect birds would be greater than under Alternatives A, B-1 or B-2, as the amount of high use bird habitat that would be lost to gravel infrastructure would be greater, and there would be a higher potential for infrastructure to be located in areas of high bird use in the Teshekpuk Lake Special Area. It is expected that impacts to birds in the vicinity of Teshekpuk Lake and throughout the northern portion of the planning area would be greater under Alternative C, particularly	Non-oil and gas activities, seismic work, and drilling of exploration wells would have minor effects on bird populations. The types of impacts to birds from oil and gas development and abandonment would be similar to those discussed under Alternative A. Under Alternative D, 100 percent of the NPR-A's subsurface acres could be offered in future oil and gas lease sales. Alternative D would allow more infrastructure into areas of very high value to birds than any other alternative and consequently may result in increased habitat loss, disturbance, or mortality, particularly in the vicinity of Teshekpuk Lake and throughout the northern portion of the planning area and particularly with respect to molting

EFFECTS ON BIRDS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
development), or an oil spill. Impacts would be most likely to occur if facilities were located in habitats with high bird concentrations, in areas containing species that are vulnerable to small losses of nests, or in habitats that may be limiting for a particular species. Potential impacts to birds from an oil spill would depend on the location and size of the spill and on the time of year. Barges and other vessels could temporarily displace birds from preferred offshore and near shore areas. Effects to birds from climate warming may be positive and negative including increases in open water period, thermokarst, and sea level; drying of wetlands; and shrub expansion.	while oil and fuel spills may result in the loss of small numbers of some bird species, there would be less potential for an oil spill than in other alternatives. Population level effects would be unlikely for any bird species.	disturbed and, while oil and fuel spills may result in the loss of small numbers of some bird species, there would be less potential for an oil spill than in other alternatives. Population level effects would be unlikely for any bird species.	with respect to molting waterfowl. Crude oil and fuel spills would be greater than under Alternatives A, B-1 or B-2 and may result in the loss of small numbers of some bird species. Population level effects would be unlikely for any bird species.	waterfowl. The potential for an oil spill to impact birds would also be greatest under Alternative D. Population level effects would be unlikely for any bird species.
Cumulative Effects: Effects on birds from non-oil and gas activities that are part of BLM operations or authorizations would not be expected to accumulate. Approximately 2,500 acres of habitat have been directly impacted by non-oil and gas development, and these impacts continue to persist. Those numbers are expected to increase to approximately 4,300 acres through this century. From 1968 to the present, oil and gas activities have caused an additional habitat loss of 17,921 acres. The extent of anticipated cumulative effects on birds from oil and gas activities in the NPR-A and surrounding areas would vary depending upon the alternative selected under this IAP/EIS. Development in the NPR-A could directly impact approximately 9,902, 7,505, 8,402, 14,894, and 16,329 acres of bird habitat for Alternatives A, B-1, B-2, C, and D, respectively. Additionally, oil/gas development in the Chukchi and Beaufort offshore leases, construction of a road and pipeline(s) between Umiat and the Dalton Highway, construction of a commercial gas pipeline and unconventional oil and gas development east of the NPR-A could cause direct, impacts to bird habitat on up to 12,550 acres and indirect impacts on 37,585 acres. Large discoveries of oil in the Chukchi or Beaufort offshore could make additional developments in the northern NPR-A more economically feasible, resulting synergistically in even more habitat and disturbance impacts in the NPR-A. Cumulative effects on bird productivity and abundance are likely to be long-term and could result in adverse effects on productivity of some species of birds. If climate change over the next several decades were to result in substantial changes in vegetation and insect abundance, habitat disturbance effects from oil and gas activities could be exacerbated additively, and perhaps synergistically, and extend beyond the life of the oil and gas fields. All future impacts are additive to the impacts to bird habitat that have accumulated in the past and persist today, but in the context of the entire North Slope west of the Canning River, these cumulative impacts would be relatively small. Based on impacts to 42,050 acres that could still persist in 2100 (Table 4-8), direct impacts to habitat would occur on 0.1% of the North Slope west of the Canning River. While development could occur throughout much of this area, affecting a wide variety of habitat of value to birds, it is likely that the focus of future oil exploration and development would remain relatively near to the coast, where particularly valuable waterfowl and shorebird habitats are located.				

EFFECTS ON TERRESTRIAL MAMMALS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Non-oil and gas activities, seismic work, drilling of exploration wells, and spills would have minor effects on terrestrial mammal populations. Most effects on mammals of oil and gas development activities would be localized and short term, and would not occur at the population level. Some Teshekpuk Caribou Herd caribou would likely be disturbed and their movements temporarily altered during periods of facilities construction. Near operating oil or gas fields, surface, air, and foot traffic is expected to displace some terrestrial mammals. If oil or gas field development occurred in Teshekpuk Caribou Herd calving or insect-relief areas, calving could be displaced or movements of caribou from coastal insect-relief areas to inland foraging areas could be adversely affected. A model of displacement from high-value calving habitat suggests that 78% (95% confidence interval: 70-84%) would remain. These changes in caribou distribution could result in reduced productivity and ultimately a population level effect, although the latter is considered a low probability result. Crude oil and fuel spills may result in the loss of small numbers of some terrestrial mammal species. Overall, impacts to terrestrial mammals from oil and gas activities would be expected to be mostly minor and local. This may	Non-oil and gas activities, seismic work, drilling of exploration wells, and spills would have minor effects on terrestrial mammal populations. Effects of oil and gas development activities would occur over slightly less of the NPR-A than under Alternative A, and consequently a lower number of animals would potentially be disturbed. Impacts to terrestrial mammals in the vicinity of Teshekpuk Lake would be less than under Alternative A because the area would be unavailable for leasing, providing greater protection for caribou calving and insect-relief habitat. From the perspective of terrestrial mammals, this increased protection for the Teshekpuk Caribou Herd under Alternative B-1 is the most salient difference between it and Alternative A. A model of displacement from high-value calving habitat suggests that 92% (95% confidence interval: 90-93%) would remain. Insect-relief areas and calving areas for the Western Arctic Herd would also be unavailable for leasing, providing substantial protections for that caribou herd. This is essentially the same effect for the Western Arctic Herd as the unplanned, southwestern portion of the NPR-A under Alternative A. Lease stipulations and best management practices would help minimize remaining impacts to terrestrial mammals. Crude	Non-oil and gas activities, seismic work, drilling of exploration wells, and spills would have minor effects on terrestrial mammal populations. Effects of oil and gas development activities would occur over less of the NPR-A than under Alternative A but slightly more than under Alternative B-1. Disturbance of animals among these three alternatives would be proportional to the area affected. Impacts to terrestrial mammals in the vicinity of Teshekpuk Lake would be less than under Alternative A because the area would be unavailable for leasing, but slightly more than under Alternative B-1 because a smaller area would preclude non-subsistence permanent infrastructure. As a result, there would be slightly less protection for caribou calving and insect-relief habitat than with Alternative B-1. For the Teshekpuk Caribou Herd, a model of displacement from high-value calving habitat suggests that 91% (95% confidence interval: 87-93%) would remain. Insect-relief areas and calving areas for the Western Arctic Herd would also be unavailable for leasing, providing substantial protections for that caribou herd. Lease stipulations and best management practices would help minimize remaining impacts to terrestrial mammals. Crude oil and fuel spills may	Non-oil and gas activities, seismic work, drilling of exploration wells, and spills would have minor effects on terrestrial mammal populations. Effects of oil and gas development activities could occur over all of the terrestrial portions of the NPR-A, with the exception of the southern tier from roughly the Colville River to the Brooks Range crest. This is a greater area than under Alternative A, B-1 or B-2, but less than Alternative D. Consequently, a greater number of animals and a greater area of habitat would potentially be disturbed than under the previous three alternatives. Impacts to terrestrial mammals, and especially the Teshekpuk Caribou Herd, in the vicinity of Teshekpuk Lake would be greater than under Alternative B-1 or B-2, particularly with respect to Teshekpuk Caribou Herd calving and insect-relief habitat. A model of displacement from high-value calving habitat suggests that 82% (95% confidence interval: 75-87%) would remain. A substantial portion of the Western Arctic Herd calving area, but not insect-relief area, would also be available for leasing. This area is also important for grizzly bears, wolves and wolverines, so they too would be susceptible to greater disturbance under Alternative C. Lease stipulations and best management practices	Non-oil and gas activities, seismic work, drilling of exploration wells, and spills would have minor effects on terrestrial mammal populations. Effects of oil and gas development activities could occur over the entire NPR-A, since no area would be unavailable for leasing. In addition, there would be fewer restrictions (best management practices) on development and oil field operations, providing another avenue for increased impacts to terrestrial mammals over the other alternatives. Crude oil and fuel spills may result in the loss of small numbers of some terrestrial mammal species. Overall, a greater amount of mammal habitat would be affected and more animals would be disturbed than under the other alternatives, but these levels of impacts would still be unlikely to reach a population level effect for species other than caribou. Compared to the other alternatives, both Teshekpuk Caribou Herd and Western Arctic Herd caribou would be at greater risk of population level effects, but due to the assumed distribution of oil and gas resources this is less likely for the Western Arctic Herd than for the Teshekpuk Caribou Herd. A model of displacement from high-value calving habitat for the Teshekpuk Caribou Herd suggests that 75% (95%

EFFECTS ON TERRESTRIAL MAMMALS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
not be the case for Teshekpuk Caribou Herd, however, which could experience some population level effects.	oil and fuel spills may result in the loss of small numbers of some terrestrial mammal species. In summary, a smaller amount of mammal habitat would be affected and less animals would be disturbed than under Alternative A. Population level effects would be unlikely for species of terrestrial mammals.	result in the loss of small numbers of some terrestrial mammal species. In summary, a smaller amount of mammal habitat would be affected and less animals would be disturbed than under Alternative A, but perhaps slightly more than under Alternative B-1. Population level effects would be unlikely for species of terrestrial mammals.	would help minimize impacts to terrestrial mammals. Crude oil and fuel spills may result in the loss of small numbers of some terrestrial mammal species. Overall, a greater amount of mammal habitat would be affected and more animals would be disturbed than under Alternatives A, B-1, or B-2. These increases would still be unlikely to reach a population level effect for species other than caribou. Compared to Alternatives A, B-1 or B-2, both Teshekpuk Caribou Herd and Western Arctic Herd caribou would be at greater, but still low, risk of a population level effect under Alternative C.	confidence interval: 67-82%) would remain.

Cumulative Effects: Approximately 2,500 acres of habitat have been directly impacted by non-oil and gas development, and these impacts continue to persist. Those numbers would increase to approximately 4,300 acres through this century. From 1968 to the present, oil and gas activities have caused an additional habitat loss of 18,153 acres. Since most of the impacts to habitat are associated with ongoing residential and non-oil and gas commercial development, or oil and gas activities, these impacts to habitat are additive to future impacts and would be likely to persist indefinitely in the absence of an active reclamation program. Oil and gas development has altered the distribution of female caribou during the calving season and interfered with caribou movements between inland feeding areas and coastal insect-relief areas. Female caribou may also experience lower parturition rates when in close proximity to oil field development. It has also been suggested that declines in Central Arctic Herd caribou productivity in the early 1990s may have been the result of additive effects of oil field development and high insect activity, although populations of Central Arctic Herd caribou have displayed an increasing trend from the mid-1970s to the present. Thus, disturbance of caribou due to oil field development may adversely affect caribou, but these effects may not be readily apparent based on population trends. Other mammal populations (e.g., fox and grizzly bear) have been little affected, or may even have benefited from development on the North Slope. Based on population trends of game mammals on the North Slope, hunting does not appear to be adversely affecting mammal populations. Development in the NPR-A could directly impact approximately 9,902, 7,505, 8,402,15,311, and 16,329 acres, and indirectly impact 29,301, 20,734, 23,596, 39,062, and 43,574 acres of mammal habitat for Alternatives A through D, respectively. Additionally, oil/gas development in the Chukchi and Beaufort offshores, construction of a road and pipeline(s) between Umiat and the Dalton Highway; construction of a commercial gas pipeline and unconventional oil and gas development east of the NPR-A could cause direct, terrestrial impacts on up to 12,630 acres and indirect impacts on 37,585 acres. Any development in the vicinity of Teshekpuk Lake or the southwestern portion of the NPR-A, areas that provide important calving and insect-relief habitat for Teshekpuk Caribou Herd and Western Arctic Herd caribou, could result in greater impacts to caribou and perhaps other mammals and their habitats than predicted based solely on the amount of area disturbed. Any reduction in calving and summer habitat use by caribou cows and calves as a result of avoiding oil and gas activities would represent a functional loss of habitat. Cumulative effects on caribou distribution and abundance are likely to be long term and could result in adverse effects on caribou productivity. Large discoveries of oil in the Chukchi or Beaufort offshore could make additional developments in the northern NPR-A more economically feasible, resulting synergistically in even more habitat and disturbance impacts in the NPR-A. If climate change over the next several decades were to result in substantial changes in vegetation and insect abundance, habitat disturbance effects from oil and gas activities could be exacerbated additively, and perhaps synergistically, and extend beyond the life of the oil and gas fields. If these cumulative effects were to result in reductions of caribou populations, there could also be a reduction in the abundance of predators such as wolves, bears, and wolverines.

EFFECTS ON MARINE MAMMALS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Effects from non-oil and gas activates will likely be short-term and localized and occur within a few miles of the disturbance source. Impact sources could include private or commercial air traffic; aerial surveys to inventory wildlife or other resources; summer research camps; hazardous material or debris removal; recreational camps and boating activity; and subsistence. The most likely oil-and gas-related effects on whales are disturbance-related effects from marine shipping/barging; however, occasional vessel collisions are possible for large whales. Short-term avoidance behaviors including dives, direction changes, and temporary abandonment of areas may occur as the result of ship traffic or aircraft. Because the number of activities that may cause disturbance are expected to be few, limited seasonally, and generally in areas/times where whales are not concentrated, it is unlikely that lasting impacts and significant effects occur. Noise associated with support aircraft could disturb seals and temporarily displace them from preferred resting and feeding locations. Summer air traffic could disturb ringed, bearded, and spotted seals hauled out on ice or beaches. Ribbon seals are unlikely to be disturbed by nearshore activities. A small number of ringed seals, spotted seals, or beluga whales could be adversely affected by oil spills	Effects under Alternative B-1 would possibly be less than for Alternative A, since less acreage is available for development, there could be a proportionally lower potential activity that would disturb marine mammals. Type of impacts and disturbances would be similar to Alternative A and most likely come from anthropogenic sounds, ship strikes, or habitat degradation. Sound sources include vessels and aircraft, seismic operations, construction of facilities close to the coast, or production and transport of oil or gas. Effects from NPR-A activities are expected to be localized and short term, and would not substantially affect marine mammal populations. The potential effects of an oil spill would be similar to those under Alternative A, although the likelihood of a spill could be somewhat less. Alternatives B-1, B-2, and C offer the most marine special areas. Together with stipulation K-3, this might minimize the potential for oil development near the coast to impact ringed seals, spotted seals, and beluga whales. Significant physical habitat changes are not expected. Due to the possibly of less activity (i.e., less acreage offered), there will likely be lower aircraft and barge traffic. Alternative B-1 has a lower likelihood of impacting marine mammals (particularly beluga and large baleen whales) than the other alternatives. However, the potential for	Effects under Alternative B-2 would be similar to Alternative B-1, but would be less than under Alternatives A, C, or D. Less acreage is available for development compared to these latter three alternatives, resulting in proportionally lower potential activity that could disturb marine mammals. Type of impacts and disturbances would be similar to Alternative A and most likely come from anthropogenic sounds, ship strikes, or habitat degradation. Sound sources include marine vessels and aircraft, onshore seismic operations, construction of facilities close to the coast, or production and transport of oil or gas. Effects from NPR-A activities are expected to be localized and short term, and would not substantially affect marine mammal populations. The potential effects of an oil spill would be similar to those under Alternative A; the likelihood of an onshore spill reaching marine waters is, however, greatly reduced through several mitigation measures included in Stipulations K-1 and K-6. The set-back requirements of these stipulations should also decrease noise transmission from onshore activities to sensitive coastal and nearshore marine waters. The same Special Areas are proposed under Alternative B-2 as under Alternatives B-1 and C, although the proposed acreage differs. The two Special Areas of greatest importance to marine mammals,	The types of activities that would affect large whales in Alternative C would be similar to those in the other alternatives and would possibly scale with the amount of acreage leased. That is, more leased acreage could lead to more oil and gas activity than Alternatives A, B-1, and B-2, but less than D; resulting in more barge traffic to haul and supply oil and gas operations. Effects associated with barging and shipping activity would be the principal concerns. The larger area opened for development is expected to translate into greater aircraft and vessel traffic than under other alternatives. Effects should be localized and short term, and would not cause significant impacts to marine mammal populations. Making many coastal waters unavailable for leasing and Stipulation K-6 would minimize the potential for oil development near the coast to impact ringed seals, spotted seals and beluga whales.	Effects from Alternative D would likely be higher and protections fewer (for seals and odontocetes) than under the other alternatives. More leases are available and fewer protections for many of the coastal waterbodies. Only one marine Special Area is included. If there is more oil and gas activity with more leases there might be an increase in aircraft use within NPR-A, more barge activity to transport exploration equipment to NPR-A for use in the winter and possibly more seismic surveys. If this occurs, more whales may be exposed to more anthropogenic sounds, increasing the possibility of deflection from preferred areas. There would also be an increased possibility of ship strikes. Even though the impacts under Alternative D would be expected to be higher, impacts to belugas, harbor porpoises and killer whales would still be small because most of the activity would occur at inland locations or during winter. Large whales would be mainly affected by barge and tug traffic. This alternative is not expected to physically impact habitat; therefore potential impacts are expected to come primarily mechanized operations and introduced contaminants.

EFFECTS ON MARINE MAMMALS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
associated with major NPR-A drainages that reach the sea. Losses would be small and would not substantially impact marine mammal populations. Effects from oil spills could cause some mortality if oil were transported to the sea via rives, or fuel spills occurred during barge operations.	impacts to seals under Alternative B-1 may be similar to that of Alternatives B-2 and C due to their similar Peard Bay and Kasegaluk Lagoon Special Areas.	Kasegaluk Lagoon and Peard Bay Special Areas, are smaller than under Alternative B-1, but the same size as under Alternative C. The area removed, however, is terrestrial, so of little consequence to marine mammals. Although land included in Special Areas is smaller than under Alternative B-1 and coastal lands made available to new non-subsistence infrastructure is greater, required protective measures of several Stipulations and Best Management Practices included under Alternative B-2 should minimize potential impacts, such as disturbance and habitat degradation, to marine mammals.		
Cumulative Effects: In the Arctic, industrial sounds and other disturbances have displaced whales from preferred habitats; these effects can be difficult to quantify and to determine if they accumulate. In addition to noise and disturbance from existing oil development, seals and beluga and gray whales could be affected by future offshore development in the Beaufort and Chukchi seas. Furthermore, marine mammals wintering in the northern Bering Sea are affected by disturbance from commercial fishing activities to varying degrees (e.g., mortality associated with Bering Sea crab fisheries is documented for bowhead whales). Subsistence hunting of marine mammals by Alaska Natives is not likely to affect marine mammals at the population level. Disturbance could result in temporary displacement from preferred feeding habitats. An oil spill could affect marine mammals in offshore or coastal areas, with the impacts depending on the location and amount of oil spilled and time of year. The effects of future habitat alteration associated with gravel island construction, platforms, or other structures related to oil development would likely be minor. The presence of small amounts of hazardous materials, including hydrocarbons and previously used insecticides, would likely have minor effects on marine mammals. The effects of global climate change on marine mammals are unclear and will affect species differently. While a reduction in the extent of Arctic ice coverage would likely have a negative impact on ice-dependent seal populations, an increase in the amount of sea ice edge resulting from global warming may be beneficial to some whale species. Northern Alaska fisheries are small and likely have only a minor impact on marine mammal populations; mainly seals and beluga whales. Impacts to marine mammals from development in the NPR-A would be similar under all alternatives. The increased development scenarios of Alternatives C and D could contribute additional barge and aircraft traffic impacts and would require a greater number of coastal staging areas than the development scenario under Alternatives A, B-1, and B-2. If additional staging areas along the NPR-A coast lead to increased offshore exploration and development activities, the potential for cumulative impacts to marine mammals by noise or other activities would increase. Whale species most likely to experience cumulative effects include gray and beluga whales. Increases in ice-free periods and ice retreat may be accompanied by a northward shift in commercial fisheries and shipping traffic, potentially increasing rates of disturbance, entrapment, entanglement, and vessel strikes. Offshore oil and gas exploration and development, should it occur in areas occupied by whales, would result in disturbance effects and may impact foraging success, possibly to the extent that fitness is reduced. However, these potential impacts are not clearly linked to the alternatives within the plan. Activities associated with plan alternatives could affect whales resulting in displacement, disturbance, masking of whale sounds, and potential vessel strikes. Disturbance, displacement, and masking could affect foraging success and possibly influence fitness. Because of limited data on marine mammals and the lack of adequate quantitative approaches for assessing cumulative impacts, it is not feasible to determine whether the cumulative effects from NPR-A activities in combination with other human activities in the Arctic would be significant.				

EFFECTS ON SPECIAL STATUS SPECIES

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
The effects on special status species vegetation, birds, terrestrial mammals, and whales and seals will be the same as described for this alternative under "Effects on Vegetation," "Effects on Birds," "Effects on Terrestrial Mammals," and "Effects on Marine Mammals," respectively. Potential for non-oil and gas activities to disturb individual polar bears and walrus, with no long-term impacts to individual bears expected, but activities that occur too close to walrus haulouts could lead to disturbance and mortality of many individuals. Potential for oil and gas activities to disturb individual polar bears and walrus and temporarily prevent some animals from using small portions of habitat. No measurable effects expected at population level from most oil and gas activities (with the exception of a large oil spill). Potential effects of disturbance, habitat loss/alteration, and potential development-related mortality under Alternative A would be lower than under Alternative D but greater than under Alternatives B-1, B-2, and C. A large oil spill could have population-level effects to polar bears and walrus in some circumstances. Risk of a large oil spill is higher under Alternative A than under Alternatives B-1 and B-2 but similar to the risk under Alternatives C and D.	The effects on special status species vegetation, birds, terrestrial mammals, and whales and seals will be the same as described for this alternative under "Effects on Vegetation," "Effects on Birds," "Effects on Terrestrial Mammals," and "Effects on Marine Mammals," respectively. Types of effects on polar bears and walrus will be similar to Alternative A, but the potential effects of disturbance, habitat loss/alteration, oil spills, and potential development-related mortality would be less than under Alternative A.	The effects on special status species vegetation, birds, terrestrial mammals, and whales and seals will be the same as described for this alternative under "Effects on Vegetation," "Effects on Birds," "Effects on Terrestrial Mammals," and "Effects on Marine Mammals," respectively. In addition, Best Management Practice H-1 under Alternative B-2 requires barge operators to demonstrate that barge activities will not have unmitigable adverse impacts on the availability of marine mammals to subsistence hunters; this would also mitigate disturbance effects to subsistence resources, including bowhead whales. Types of effects on polar bears and walrus will be similar to Alternative A, but the potential effects of disturbance, habitat loss/alteration, oil spills, and potential development-related mortality would be less than under Alternative A or B-1.	The effects on special status species vegetation, birds, terrestrial mammals, and whales and seals will be the same as described for this alternative under "Effects on Vegetation," "Effects on Birds," "Effects on Terrestrial Mammals," and "Effects on Marine Mammals," respectively. Types of effects on polar bears and walrus will be similar to Alternative A, but the potential effects of disturbance, habitat loss/alteration, oil spills, and potential development-related mortality would be less than under Alternatives A and D, and greater than under Alternative B-1 or B-2.	The effects on special status species vegetation, birds, terrestrial mammals, and whales and seals will be the same as described for this alternative under "Effects on Vegetation," "Effects on Birds," "Effects on Terrestrial Mammals," and "Effects on Marine Mammals," respectively. Types of effects to polar bears and walrus will be similar to Alternative A, but the potential effects of disturbance, habitat loss/alteration, oil spills, and potential development-related mortality under Alternative D would be greater than under any other alternative.

EFFECTS ON SPECIAL STATUS SPECIES

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Cumulative Effects: The cumulative effects on special status species vegetation, birds, terrestrial mammals, and whales and seals will be the same as described for this alternative under "Effects on Vegetation," "Effects on Birds," "Effects on Terrestrial Mammals," and "Effects on Marine Mammals," respectively. Routine authorized activities will be required to have negligible effects on polar bears and their habitats and to walrus. Fuel and oil spills could cause mortality of polar bears and walrus, and their prey, with possible impacts to the local population.				

EFFECTS ON CULTURAL RESOURCES

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
The effects of long-term disturbance – the development of production wells and associated infrastructure - pose the greatest potential impact to cultural resources; most specifically, as the result of excavation of gravel, gas line trenching, and the use of the excavated material to construct roads, airstrips and pads. A lower potential impact exists from exploration activities that are undertaken during the winter months with infrastructure constructed of snow and ice. Lower still is the potential from non-oil and gas activities to cause adverse effects. A catastrophic oil or gas well blowout would probably destroy or render scientifically valueless any nearby cultural resource site. Abandonment and reclamation of infrastructure would, under normal circumstances, have limited if any impact on the resource. Under this Alternative as much as 40 million cubic yards of mineral material could be excavated from material sites and 3.2 million cubic yards from pipeline trenching. In addition, approximately of 9,902 acres could be impacted by	The effects of long-term disturbance – the development of production wells and associated infrastructure - pose the greatest potential impact to cultural resources; most specifically, as the result of excavation of gravel, gas line trenching, and the use of the excavated material to construct roads, airstrips and pads. A lower potential impact exists from exploration activities that are undertaken during the winter months with infrastructure constructed of snow and ice. Lower still is the potential from non-oil and gas activities to cause adverse effects. A catastrophic oil or gas well blowout would probably destroy or render scientifically valueless any nearby cultural resource site. Abandonment and reclamation of infrastructure would, under normal circumstances, have limited if any impact on the resource. Under this Alternative as much as 29million cubic yards of mineral material could be excavated from material sites and 3.3 million cubic yards from pipeline trenching. In addition, approximately 7,505 acres could be impacted by infrastrucucture	The effects of long-term disturbance – the development of production wells and associated infrastructure - pose the greatest potential impact to cultural resources; most specifically, as the result of excavation of gravel, gas line trenching, and the use of the excavated material to construct roads, airstrips and pads. A lower potential impact exists from exploration activities that are undertaken during the winter months with infrastructure constructed of snow and ice. Lower still is the potential from non-oil and gas activities to cause adverse effects. A catastrophic oil or gas well blowout would probably destroy or render scientifically valueless any nearby cultural resource site. Abandonment and reclamation of infrastructure would, under normal circumstances, have limited if any impact on the resource. Under this Alternative as much as 31 million cubic yards of mineral material could be excavated from material sites and 3.3 million cubic yards from pipeline trenching. In addition, approximately 8,404 acres could be impacted by infrastructure	The effects of long-term disturbance – the development of production wells and associated infrastructure - pose the greatest potential impact to cultural resources; most specifically, as the result of excavation of gravel, gas line trenching, and the use of the excavated material to construct roads, airstrips and pads. A lower potential impact exists from exploration activities that are undertaken during the winter months with infrastructure constructed of snow and ice. Lower still is the potential from non-oil and gas activities to cause adverse effects. A catastrophic oil or gas well blowout would probably destroy or render scientifically valueless any nearby cultural resource site. Abandonment and reclamation of infrastructure would, under normal circumstances, have limited if any impact on the resource. Under this Alternative as much as 52 million cubic yards of mineral material could be excavated from material sites and 8.3 million cubic yards from pipeline trenching. In addition, approximately 15,311 acres could be impacted by	The effects of long-term disturbance – the development of production wells and associated infrastructure - pose the greatest potential impact to cultural resources; most specifically, as the result of excavation of gravel, gas line trenching, and the use of the excavated material to construct roads, airstrips and pads. A lower potential impact exists from exploration activities that are undertaken during the winter months with infrastructure constructed of snow and ice. Lower still is the potential from non-oil and gas activities to cause adverse effects. A catastrophic oil or gas well blowout would probably destroy or render scientifically valueless any nearby cultural resource site. Abandonment and reclamation of infrastructure would, under normal circumstances, have limited if any impact on the resource. Under this Alternative as much as 55 million cubic yards of mineral material could be excavated from material sites and 8.5 million cubic yards from pipeline trenching. In addition, approximately 16,329 acres could be impacted by

EFFECTS ON CULTURAL RESOURCES

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
infrastructure surface disturbance associated with oil and gas activities.	surface disturbance associated with oil and gas activities.	surface disturbance associated with oil and gas activities.	infrastructure surface disturbance associated with oil and gas activities.	infrastructure surface disturbance associated associated with oil and gas activities.
Cumulative Effects: The most important factor in regards to the probability of adversely affecting cultural sites is the geographic location in which a given development activity will take place. Cultural resource survey data suggests that the areas of highest probability for economically recoverable oil and gas in the NPR-A include some areas known to have a slightly above average density of cultural sites which suggests a moderately high potential for the presence of undiscovered sites. Most cultural resource sites because of their stratigraphic position, on or slightly beneath the surface of the ground, are vulnerable to damage or destruction from any surface disturbing activity. Surface disturbing activities include any action, which compromises the natural integrity of the ground surface including burial of the surface. Of the variety of surface disturbing activities associated with oil and gas exploration and development those that comprise transects across the landscape (roads and pipelines) have the greatest potential for impact. It is assumed that oil and gas related activities will take place in the areas of highest oil and gas potential. Therefore the larger the portion of those areas that are open to oil and gas related activities the greater the potential for impact to cultural resources and the aggregation of cumulative adverse effect. However, as has been mentioned previously, due to regulations and awareness, over the last 30 years of oil and gas exploration and development activities on the North Slope there have been few instances where cultural resources material has been adversely impacted and data lost.				

EFFECTS ON SUBSISTENCE-HARVEST PATTERNS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Non-oil and gas activities would have limited effects on subsistence resources, though short-term, localized disturbances to subsistence species and harvest patterns could occur. Most likely, subsistence hunters will avoid areas of oil and gas activities. A small number of fish could be injured or killed, potentially affecting harvests in localized areas. Subsistence species such as caribou or moose may be displaced from areas of oil and gas activity, resulting in long-term localized effects. If subsistence species move away from areas of development, they could become more difficult to locate and harvest. Waterfowl might also avoid traditional harvest locations. Oil spills that entered water could contaminate or cause concerns about	Effects would be decreased in magnitude, extent, and duration compared to those occurring under Alternative A because two million fewer acres would be open to oil and gas development and because particularly critical subsistence use areas, including most of the Teshekpuk Lake Special Area, constitute a large percentage of that protected land. Stipulations would help minimize the effects on subsistence species and harvest patterns on lands that are leased for oil and gas activities. Impacts to subsistence areas and species would be less than all other alternatives: much less than Alternative D, substantially less (due to its protection of Teshekpuk Lake Special Area) than Alternative C, and significantly less than the Alternative A. Alternative B-1	Direct effects would be decreased in magnitude, extent, and duration compared to those occurring under Alternative A because 1.2 million fewer acres would be open to oil and gas leasing, because leasing is unavailable in coastal waterbodies, and because new infrastructure would be prohibited in particularly critical calving areas of the Western Arctic Caribou Herd and Teshekpuk Lake Caribou Herd. Stipulations would help minimize the effects on subsistence species and harvest patterns on lands that are leased for oil and gas activities. Direct impacts to the Teshekpuk Lake and Western Arctic caribou herds' critical habitat would be less than Alternatives A, C, and D. Alternative B-2 could indirectly lead to more impacts	Effects would be decreased in magnitude, extent, and duration for subsistence users in most NPR-A communities than those occurring under the no-action alternative. Although this alternative makes 4.9 million more acres available for oil and gas leasing than the no-action alternative, several key subsistence use areas (i.e., major coastal waterbodies) would be unavailable for leasing and a significantly larger area within the Teshekpuk Lake Special Area would be unreachable due to stricter regulations. The availability of land in the southwest area of the NPR-A near Point Lay may result in greater impacts to that community's terrestrial subsistence use areas. Impacts would be greater than those under Alternatives B-1 and B-2,	Effects would be greater in magnitude, extent, and duration than those occurring under all other alternatives. All lands within the NPR-A would be made immediately available for leasing although current deferrals would be honored pending expiration. Several stipulations common to other alternatives to protect biological resources near Teshekpuk Lake would not apply or would be less restrictive.

EFFECTS ON SUBSISTENCE-HARVEST PATTERNS

<table>
<tr><th>Alternative A
(No-action Alternative)</th><th>Alternative B-1</th><th>Alternative B-2
(Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>contamination of marine mammals and fish.</td><td>would be more protective of subsistence resources and use areas than Alternative B-2, the preferred alternative, because it prohibits leasing and non-subsistence infrastructure from the Teshekpuk Lake, Utukok River Uplands, the Kasegaluk Lagoon, and the Peard Bay Special Areas, and all coastal waterbodies except the Kuk River/Wainwright Inlet. Alternative B-2 prohibits leasing in those areas but prohibits non-subsistence infrastructure only in the core Teshekpuk Lake area</td><td>than Alternatives A, B-1, and C due to its accommodation of pipelines and infrastructure associated with offshore oil development, which it would prohibit only in the core Teshekpuk Lake area and most of the Utukok River Uplands Special Area. Of particular concern for subsistence resources and use areas is the lowered amount of protection for the Kasegaluk Lagoon and Peard Bay Special Areas compared to Alternative B-1.</td><td>decreased as compared to Alternative A, and much less than Alternative D.</td><td></td></tr>
<tr><td colspan="5">Cumulative Effects: Prior to sustained contact between the Iñupiat of the North Slope and Euro-Americans, the Iñupiat were a highly mobile, geographically widespread, and technologically capable people who lived in dispersed, small communities based on family and social connections. They harvested local resources as needed and as available. Beginning with commercial whaling in the 1850s and followed by establishment of the Naval Petroleum Reserve and subsequent exploration activity in lands occupied by the Iñupiat of the North Slope, the Iñupiat have had to adapt to the “external pressures impacting their environment and regulatory actions that restrict their subsistence pursuits.” Subsistence is currently, and has been since the mid-19th century, part of a rural economic system, called a “mixed, subsistence-market” economy, wherein families invest money into small-scale, efficient technological innovations to support subsistence activities (e.g., traps, boat motors, snowmachines). Avoidance of former harvest areas due to industrial activity was made possible by motorized transportation. During this 160-year period, the Iñupiat have had to continually adapt to the constraints placed upon their subsistence activities and lifestyle by cultures other than their own. The effects of these constraints on the Iñupiat persist today and will accumulate with future effects on their subsistence resources and lifestyle. Most notable among future effects will be (1) the ongoing impacts of climate change, which are likely to continue and intensify, and (2) those caused by the potential development of offshore oil and gas reserves, particularly if onshore facilities include pipelines and access roads that traverse the NPR-A to connect with the Trans-Alaska Pipeline System. Numbers of animals available for harvest could be reduced through the slow reduction of species by habitat loss, predation, climate change, and disease. Diverting animals from their usual and accustomed locations, or building facilities in proximity to those locations, could compel resource harvesters to travel further to avoid development areas. Harvest of subsistence resources in areas further from communities would require increased effort, risk, and cost on the part of subsistence users. Increasing areas open for leasing and exploration would lead to development in previously closed areas, leading to concentrating subsistence harvest efforts in undeveloped areas and increasing the potential for conflict over harvest areas within and between communities. Climate change and the associated effects of anticipated warming of the Arctic climate regime could significantly affect subsistence harvests and uses if warming trends continue as predicted. Every community in the Arctic is potentially affected by the anticipated climactic shift and few plans are in place for communities to adapt to or mitigate these potential effects. The reduction, regulation, and/or loss of subsistence resources would have severe effects on the subsistence way of life for residents of Nuiqsut, Atqasuk, Barrow, Point Lay, Wainwright, and Anaktuvuk Pass. If the loss of permafrost and of conditions beneficial to the maintenance of permafrost increase as predicted, there could be synergistic cumulative effects on infrastructure, travel, landforms, sea ice, river navigability, habitat, availability of fresh water, and availability of terrestrial mammals, marine mammals, waterfowl and fish, all of which could necessitate relocating communities or their population, shifting the population to places with better subsistence hunting, and causing a loss or dispersal of community. Allowing infrastructure that accommodates offshore development in the Teshekpuk Lake Special Area would reduce the amount of undisturbed habitat to caribou, waterfowl, fish, and other subsistence species. Effects to subsistence species would be greatest under Alternative D, which makes all of the NPR-A available for leasing. Effects to subsistence species would be least under Alternative B-1, which protects more critically important subsistence areas than other alternatives. Alternative B-2 would protect the Teshekpuk Lake Special Area from leasing and the area directly around and to the north of Teshekpuk Lake from pipelines and associated infrastructure. Alternative B-2 would also protect the habitat of the Western Arctic Caribou Herd. However, cumulative impacts of large pipeline projects could include a large amount of land that would be avoided by subsistence hunters and could interfere with caribou herd migrations. Lease stipulations would reduce the likelihood of cumulative effects to subsistence resources but would have little effect on limitations to subsistence access.</td></tr>
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EFFECTS ON SOCIOCULTURAL SYSTEMS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Oil and gas development in the planning area would further the perception that local residents are being surrounded by development, and would increase the difficulty, expense, and risk of traveling to subsistence harvest areas. As a result, the continued use of and access to traditionally used lands could decrease, potentially threatening the subsistence way of life. Nuiqsut, Atqasuk, Barrow, Wainwright, Point Lay and Anaktuvuk Pass could be affected. Oil spills in the marine or nearshore environment could disrupt subsistence harvests by contaminating resources, or causing the perception that resources were contaminated. Stipulations would provide protections for subsistence resources, cabins, camps, and river corridors, as well as a system of negotiating conflicts between permittees, leaseholders, and subsistence users, and would help to allow cultural values to coexist with development.	Direct effects to traditional use areas and subsistence resources would be lesser in magnitude and extent than those occurring under all other alternatives. . However, sociocultural impacts could result from fewer opportunities for development and resultant revenue to the North Slope Borough. The protection of the Teshekpuk Lake Special Area could result in greater food security and thus alleviate societal stress in Barrow, Nuiqsut, Atqasuk and, Anaktuvuk Pass. Making lands unavailable for leasing and prohibiting non-subsistence infrastructure in major coastal waterbodies would be particularly effective at providing security for communities' sociocultural systems by protecting their core subsistence use areas.	Direct effects would be lesser in magnitude and extent than those occurring under Alternatives A, C, and D. The protection of the Teshekpuk Lake Special Area could result in greater food security and thus alleviate societal stress in Barrow, Nuiqsut, Atqasuk, and Anaktuvuk Pass. Making major coastal waterbodies unavailable for leasing, prohibiting non-subsistence infrastructure near Teshekpuk Lake and in southwestern NPR-A, and the creation of the Peard Bay Special Area would be particularly effective at providing security for communities' sociocultural systems by protecting their core subsistence use areas. Alternative B-2 could result in greater economic security than B-1 by offering greater opportunity for development, particularly offshore.	Effects would be lesser in magnitude and extent than those occurring under the no-action alternative. Although this alternative makes more land available for leasing than the no-action alternative, the protection of coastal waterbodies is key in providing security to the basis of sociocultural systems in NPR-A communities. Because this alternative makes more land in the southwest area of NPR-A available for leasing, the community of Point Lay could be less protected. Effects would be substantially reduced from those occurring under Alternative D. Because the Teshekpuk Lake Special Area would be less protected under this alternative than under Alternatives B-1 and B-2, effects would be somewhat greater than under those alternatives.	Effects would be greater in magnitude and extent than under the other alternatives, as the amount of oil exploration and development activity and area of disturbance would be greatest under this alternative than the no-action alternative, affecting more traditional use sites and increasing the likelihood of conflicts between industry and the subsistence way of life. Negative impacts to sociocultural systems would result if families were discouraged from using traditional sites and if concerns about encroachment, pollution, and contamination of subsistence resources were realized.

EFFECTS ON SOCIOCULTURAL SYSTEMS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Cumulative Effects: Impacts to the sociocultural systems of the Iñupiat of the North Slope have occurred since the first direct interactions with non-Natives in the first quarter of the 19th century. Since that time, the Iñupiat have adapted to new technologies, new external pressures, and regulatory actions. By the mid-20th century, Iñupiat settlement patterns had changed significantly. The population became centralized into a few communities, when they previously had been spread in small family-based units across the North Slope. The cumulative effects of oil and gas development on sociocultural patterns over the last 50 years are hard to establish with quantitative precision given the lack of baseline data. Nonetheless, there is evidence that North Slope sociocultural systems have been subject to ongoing, additive, and synergistic cumulative impacts. Stresses on North Slope sociocultural systems include residents' inability to access traditional use areas, threats to resources/life ways and to spiritual connection with the land, having to deal with multiple environmental impact assessments and other development processes, and being ignored or discounted by agency representatives. Long-term stresses would result in greater impacts to sociocultural systems. The possibility of a major oil spill in the marine environment and its effects on bowhead whales, other marine mammals, and fish is residents' greatest concern—now increased significantly by the greater likelihood of offshore oil and gas activity in both the Chukchi and Beaufort seas. These and other stresses accumulate because they interact and are repeated with each new lease sale, EIS, development proposal, and facility expansion. These effects would be greatest under Alternative D because the entire NPR-A would be available for oil and gas leasing and development. However, the amount of wealth, including income from royalties, taxes, and jobs, generated by oil and gas activity and available to residents of the North Slope would be anticipated to be greater under this alternative than the other alternatives. The effects on wealth and on subsistence resources would be least under Alternatives B-1 and B-2, while the effects on wealth under the no-action alternative and Alternative C would be similar, but Alternative A (no action) would have greater impacts on subsistence use areas.				

EFFECTS ON ENVIRONMENTAL JUSTICE

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Impacts to subsistence species and harvest patterns (as discussed above) would also have disproportional impacts on the minority Iñupiaq population, which is dependent on subsistence resources. As effects to subsistence species would likely be localized, short term, and minor, environmental justice effects would be minor as well. In the unlikely event that a major oil spill occurred in a key harvest area or near a community, environmental justice effects would be much greater.	Effects would be lesser in magnitude and extent than under the other alternatives in terms of subsistence use areas and species but may also result in reduced economic gains for NPR-A communities. Any effects would have disproportional impacts on the minority Iñupiaq population. This alternative protects culturally and subsistence-wise important land in the Teshekpuk Lake Special Area and coastal waterbodies. Unless economic shortages occur, this alternative would be the least disruptive and the least likely to involve environmental justice issues. This alternative reduces the risk of oil spills in the nearshore marine environment where a large spill would have serious environmental justice effects.	Effects would be lesser in magnitude and extent than under alternatives A, C, and D in terms of subsistence use areas and species, but the alternative would not prohibit development that could contribute to economic security. Any effects would have disproportional impacts on the minority Iñupiaq population. Alternative B-2 protects culturally and subsistence-wise important land in the Teshekpuk Lake Special Area, Utukok River Uplands Special Area, and coastal waterbodies. Whether this alternative will create environmental justice issues will be largely determined by the indirect cumulative effects associated with the broader development scenario on the North Slope.	Effects would be lesser in magnitude, extent, and duration than under Alternative A (no action), would be substantially less than under Alternative D, and would be somewhat greater than under Alternatives B-1 and B-2.	Effects would be greater in magnitude and extent than under the other alternatives, as the amount of oil exploration and development activity and area of disturbance would be greatest under this alternative than under all other alternatives. This alternative makes the entire NPR-A available for oil and gas leasing. Lease stipulations would mitigate impacts to subsistence resources, however, this alternative lacks any special protections for critical subsistence use areas and would likely have negative impacts that would disproportionately affect Iñupiat.

EFFECTS ON ENVIRONMENTAL JUSTICE

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Cumulative Effects: Euro-American presence, commercial whaling, military activities and other non-oil and gas development and oil and gas exploration and development have had cumulative impacts to Iñupiaq culture and to fish and wildlife used for subsistence. Euro-American presence has impacted the Iñupiat through disease and a variety of socioeconomic and psychological problems that are commonly associated with colonization. Commercial whaling nearly decimated whale stocks in the Chukchi and Beaufort seas; bowhead whale populations, though recovering, remain below their levels in the 1800s. Non-oil and gas development associated with military, residential, and commercial development have directly impacted several thousand acres of fish and wildlife habitat and has also indirectly affected habitat and animal behavior; these impacts have accumulated and persist today. Oil and gas exploration and development conducted by the federal government and industry have directly impacted the habitat use and behavior of subsistence species, and these impacts persist today. These effects have disrupted subsistence uses, and may, in part, account for some of the social problems seen in the villages today. Climate change can be understood as an environmental justice issue and the Iñupiaq of the North Slope are disproportionately impacted by it both by the fact that climate changes effects are more pronounced in the western Arctic and by the fact that Iñupiaq subsistence activities are particularly dependent on ice, wind, and permafrost conditions. Under the cumulative case, proposals for offshore oil and gas development in the Chukchi and Beaufort seas cause the greatest concern, while the potential impacts of increasing onshore development made possible by pipelines to transport offshore product may also be important. Iñupiat users would be less likely to utilize for subsistence an area from 5 miles to 25 miles around permanent facilities and any possible environmental justice issues associated with the alternatives will be largely determined by the location of future development and by the economic benefits it brings. Alternative B-1 would protect the greatest amount of land that is important to Iñupiat for both cultural and subsistence reasons, while Alternative B-2 would protect more key subsistence areas than alternatives A, C, or D but would not preclude development in many high potential areas. Effects to subsistence comprise direct effects to the Iñupiat, a recognized minority population and the primary subsistence harvesters on the North Slope. Impacts to human health and well-being, social systems, and cultural values of the Iñupiat cumulatively lead to disproportionate effects on this minority population.				

EFFECTS ON RECREATIONAL RESOURCES

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
The impacts from activities not associated with oil and gas on recreation resources would be minimal, seasonal, confined to the immediate area and present only during the activity. Winter oil and gas activities would have a minimal effect on recreation resources. Long-term production activities could displace recreationists and adversely affect their experiences; 4.3 million acres could be impacted.	The impacts from activities not associated with oil and gas on recreation resources would be minimal, seasonal, confined to the immediate area and present only during the activity. Winter oil and gas activities would have a minimal effect on recreation resources. Long-term production activities could displace recreationists and adversely affect their experiences; 3.7 million acres could be impacted. Alternative B-1 would have the least long-term and seasonal impacts on recreation resources and the southern portion of the NPR-A, which has traditionally had the most special recreation permit authorizations per year, would not be available for leasing.	The impacts from activities not associated with oil and gas on recreation resources would be minimal, seasonal, confined to the immediate area and present only during the activity. Winter oil and gas activities would have a minimal effect on recreation resources. Long-term production activities could displace recreationists and adversely affect their experiences; 3.6 million acres could be impacted long term. Alternative B-2 would impact recreation resources the least of any alternative. The southern portion of the NPR-A, which has traditionally had the most special recreation permit authorizations per year, would not be available for leasing.	The impacts from activities not associated with oil and gas on recreation resources would be minimal, seasonal, confined to the immediate area and present only during the activity. Winter oil and gas activities would have a minimal effect on recreation resources. Long-term production activities could displace recreationists and adversely affect their experiences; 6.6 million acres could be impacted. Alternative C would have the second highest level of impact on recreation resources.	The impacts from activities not associated with oil and gas on recreation resources would be minimal, seasonal, confined to the immediate area and present only during the activity. Winter oil and gas activities would have a minimal effect on recreation resources. Long-term production activities could displace recreationists and adversely affect their experiences; 7.1 million acres could be impacted. Alternative D would have the highest long-term and seasonal impact on recreational resources.

EFFECTS ON RECREATIONAL RESOURCES

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Cumulative Effects: Future oil and gas activities, the road to Umiat and associated activity, the Chukchi Sea development, and the alternatives found in this IAP cumulatively would impact recreational resources through more activity, more human presence, increased noise, increased aircraft use, change in location of recreation activities, and correspondingly greater impacts on the setting, experiences, and desired beneficial outcome from recreational use of public land.				

EFFECTS ON 12 RIVERS ELIGIBLE FOR INCLUSION IN NATIONAL WILD AND SCENIC RIVERS SYSTEM

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
The impacts from activities not associated with oil and gas, and from long-tem, seasonal, and short-term oil and gas actions on outstandingly remarkable values, free flow, and water quality would be minimal. None of these river areas would be available for leasing under Alternative A, although there would be some potential for transportation or utility systems to cross the lower reaches of the Kokolik or Utukok Rivers.	The impacts under Alternative B-1 would be similar to Alternative A. Leasing could occur for a total of 146 river miles that could impact portions of the Awuna Kokolik and Utukok Rivers. Potential impacts would be mitigated by setbacks.	The impacts under Alternative B-2 would be essentially the same as under B-1, although the construction of roads, powerlines and bridges would be somewhat more likely to occur because the eligible rivers would not be managed as wild river areas as they would be under Alternative B-1.	The impacts under Alternative C would be similar to Alternative A. Leasing could occur for a total of 433 river miles along 4 eligible rivers. Potential impacts would be mitigated by setbacks.	The impacts under Alternative D would be similar to Alternative A. Leasing could occur for a total of 1135 river miles along 12 eligible rivers. Potential impacts would be mitigated by setbacks.
Cumulative Effects: Past cumulative impacts to wild and scenic river values are mainly in the form of signs of oil and gas exploration. Present cumulative impacts are negligible. Identified cumulative impacts that could occur in the future are due to factors such as crowding in the Arctic Refuge or improved access to Umiat, which could lead to significantly increased impacts from recreational use, particularly on the Utukok, the upper Colville, and the north-flowing tributaries of the Colville. It is unlikely that any of these impacts would significantly affect the eligibility of any rivers in the area for future designation as components of the national wild and scenic rivers system.				

EFFECTS ON WILDERNESS CHARACTERISTICS

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
The impacts from activities not associated with oil and gas on wilderness characteristics would be minimal and short-term, present only during the activity. Disturbance from long-term, seasonal, and short-term oil and gas actions could potentially impact slightly more than 4.3 million of the NPR-A's nearly 23 million acres in a manner that could impair wilderness characteristics. Alternative A would have the least amount of acres used to conduct seismic surveys and correspondently the lowest short term disturbance of wilderness characteristics.	The impacts from activities not associated with oil and gas on wilderness characteristics would be minimal, confined to the immediate area and for the most part concurrent with activities. Disturbance from long-term, seasonal, and short-term actions could potentially impact approximately 4.8 million of the NPR-A's nearly 23 million acres in a manner that could impair wilderness characteristics. Alternative B-1 would have the least percentage of both seasonal and short-term impacts on wilderness characteristics along with the lowest acreage of winter short-term use of all the alternatives.	The impacts from activities not associated with oil and gas on wilderness characteristics would be minimal, confined to the immediate area and for the most part concurrent with activities. Disturbance from long-term, seasonal, and short-term actions could potentially impact approximately 4.7 million of the NPR-A's nearly 23 million acres in a manner that could impair wilderness characteristics. Alternative B-2 would impact wilderness characteristics the least of any alternative.	The impacts from activities not associated with oil and gas on wilderness characteristics would be minimal, confined to the immediate area and for the most part concurrent with activities. Disturbance from long-term, seasonal and short-term actions could potentially impact approximately 6.6 million of the NPR-A's nearly 23 million acres in a manner that could impair wilderness characteristics.	The impacts from activities not associated with oil and gas on wilderness characteristics would be minimal, confined to the immediate area and for the most part concurrent with activities. Disturbance from long-term, seasonal and short-term actions could potentially impact approximately 8.8 million of the NPR-A's nearly 23 million acres in a manner that could impair wilderness characteristics. Alternative D would have the most seismic acres used, the most winter activities and the highest percentage of lands used for long-term oil and gas activity, thus having the greatest impact on wilderness characteristics.
Cumulative Effects: The wilderness characteristics of naturalness, outstanding opportunities for solitude or primitive and unconfined recreation have been minimally diminished within the Reserve by past and present non-oil and gas activity. Future activities not associated with oil and gas exploration and development could temporarily impact wilderness characteristics. Impacts to wilderness characteristics by a possible road to Umiat, Chukchi Sea development, Beaufort Sea development, and conventional oil and gas development in the Colville-Canning Area along with oil and gas exploration and development in the NPR-A cumulatively would impact wilderness characteristics in the area of these developments.				

EFFECTS ON VISUAL RESOURCES

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
The impacts from activities not associated with oil and gas on Visual Resources would be minimal, confined to the viewshed and for the most part concurrent with activities. Disturbance from long-term, seasonal and short-term actions could potentially impact approximately slightly more than 5.5 million of the NPR-A's nearly 23 million acres in a manner that could impact visual resources. The Visual Resource Management (VRM) classes determined in Alternative A are 1% VRM I, 0% VRM II, 22% VRM III, 17% VRM IV and 61% not classified.	The impacts from activities not associated with oil and gas on Visual Resources would be minimal, confined to the viewshed and for the most part concurrent with activities. Disturbance from long-term, seasonal and short-term actions could potentially impact approximately 4.8 million of the NPR-A's nearly 23 million acres in a manner that could impact visual resources. Alternative B-1 would have the least percentage of both seasonal and short-term impacts. The VRM classes determined in Alternative B-1 are 3% VRM I, 16%, VRM II, 31% VRM III, and 50% VRM IV.	The impacts from activities not associated with oil and gas on Visual Resources would be minimal, confined to the viewshed and for the most part concurrent with activities. Disturbance from long-term, seasonal and short-term actions could potentially impact approximately 4.7 million of the NPR-A's nearly 23 million acres in a manner that could impact visual resources. The acres impacted with this alternative are the least of any alternative. The VRM classes determined in Alternative B-2 are 37%, VRM II, 26% VRM III, and 37% VRM IV.	The impacts from activities not associated with oil and gas on Visual Resources would be minimal, confined to the viewshed, and for the most part concurrent with activities. Disturbance from long-term, seasonal and short-term actions could potentially impact approximately 6.6 million of the NPR-A's nearly 23 million acres in a manner that could impact visual resources. The acres impacted with this alternative are more than Alternatives A, B-1 and B-2, but less than alternative D. The VRM classes determined in Alternative C are 1% VRM I, 0% VRM II, 33% VRM III, and 65% VRM IV.	The impacts from activities not associated with oil and gas on Visual Resources would be minimal, confined to the viewshed and for the most part concurrent with activities. Disturbance from long-term, seasonal and short-term actions could potentially impact approximately 8.8 million of the NPR-A's nearly 23 million acres in a manner that could impair visual resources. The acres impacted with this alternative are more than the other alternatives. The VRM classes determined in Alternative D are 0% VRM I, 0% VRM II, 0% VRM III, and 100% VRM IV.

Cumulative Effects: Cumulatively all of the possible future activities would have an effect on visual resources. The extent of the effect would depend on the timing, location and length of time the activity took place. It is expected, however, that these impacts would be greatest within the Foreground-Middleground Zone of the viewer. Some facilities may be visible from the Background Zone and Seldom Seen Zone in areas in low elevation change or if viewed from an elevated position.

EFFECTS ON THE ECONOMY

<table>
<tr><th>Alternative A
(No-action Alternative)</th><th>Alternative B-1</th><th>Alternative B-2
(Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td>Non-oil and gas activities would continue to generate current levels of employment and income.
Governmental revenues would total $52 billion, with $24 billion to the Federal government, $24 billion to the State of Alaska, and $3.4 billion for the North Slope Borough.
An average of 577 jobs would be created for North Slope Borough residents, and a total of 417,380 direct, indirect, and induced job years would be added or continued over the life of oil and gas activities. Annual employment in the rest of Alaska would increase by 10,700 jobs.
Costs to harvest subsistence resources would increase.</td><td>Non-oil and gas activities would continue to generate current levels of employment and income.
Governmental revenues would total nearly $35 billion, with over $16 billion to the Federal government, $16 billion to the State of Alaska, and $2.5 billion for the North Slope Borough.
An average of 357 jobs would be created for North Slope Borough residents, and a total of 407,869 direct, indirect, and induced job years would be added or continued over the life of oil and gas activities. Annual employment in the rest of Alaska would increase by 7,000 jobs.
Costs to harvest subsistence resources would increase.</td><td>Non-oil and gas activities would continue to generate current levels of employment and income.
Governmental revenues would total nearly $34 billion, with over $16 billion to the Federal government, $15 billion to the State of Alaska, and $3 billion for the North Slope Borough.
An average of 386 jobs would be created for North Slope Borough residents, and a total of 429,745 direct, indirect, and induced job years would be added or continued over the life of oil and gas activities. Annual employment in the rest of Alaska would increase by 7,400 jobs.
Costs to harvest subsistence resources would increase.</td><td>Non-oil and gas activities would continue to generate current levels of employment and income.
Governmental revenues would total over $55 billion, with nearly $27 billion for the Federal government, $23 billion for the State of Alaska, and $5.4 billion for the North Slope Borough.
An average of 636 jobs would be created for North Slope Borough residents, and a total of 548,191 direct, indirect, and induced job years would be added or continued over the life of oil and gas activities. Annual employment in the rest of Alaska would increase by 11,600 jobs.
Costs to harvest subsistence resources would increase.</td><td>Non-oil and gas activities would continue to generate current levels of employment and income.
Governmental revenues would total $61 billion, with $29 billion for the Federal government, $25 billion for the State of Alaska, and $6 billion for the North Slope Borough.
An average of 680 jobs would be created for North Slope Borough residents, and a total of 589,153 direct, indirect, and induces job years would be added or continued over the life of oil and gas activities. Annual employment in the rest of Alaska would increase by 12,300 jobs.
Cost to harvest subsistence resources would increase.</td></tr>
<tr><td colspan="5">The North Slope Borough's annual petroleum property revenues of nearly $276 million may be doubled by new developments offshore and onshore outside of NPR-A. Activities within NPR-A will allow the North Slope Borough to continue or expand those revenues by $231 million annually under Alternative D. The State of Alaska Department of Revenue estimates annual petroleum revenue increasing to nearly $7.3 billion by 2020, an increase of $2.3 billion from 2010 based on known discoveries on existing leases. Revenue for new leasing offshore and onshore outside of NPR-A has not been estimated. Activities within NPR-A could add more than $1 billion annually under Alternative D. Federal royalties and other revenues from onshore petroleum production in Alaska total nearly $20.9 million. Revenues from new offshore leasing have not been estimated. Revenue from new leasing and production in NPR-A could provide nearly $12 billion per year under Alternative D.
North Slope Borough residents were recently employed in 4,640 jobs, with 277 unemployed residents and a net increase in the labor force averaging over 200 per year over the last decade. New North Slope activities outside NPR-A are expected to provide annual long-term employment for 400 residents. Statewide, employment would increase from nearly 365,000 to 377,000 under the non-NPR-A activities in the cumulative scenario, with an additional 13,000 provided by oil and gas activities within NPR-A under Alternative D. Alaska's North Slope oil and gas resources with existing infrastructure and potential development contribute to domestic production, national energy security, and the overall balance of trade.</td></tr>
</table>

EFFECTS ON PUBLIC HEALTH

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
Alternative A will contribute to the current trends in public health in the NPR-A. Both localized exploration activity and fixed production sites, particularly near villages or in areas of traditional land use may create changes in subsistence patterns, which may have adverse consequences for public health via changes in nutrition, social cohesion, and culture. Additionally, increases in injury associated with increased subsistence-related travel may be expected. Potential contamination of food and surface water is possible, though health effects are not likely to be measurable at a population level. However, the perception of contamination of traditional foods is already a problem in the region; further development may worsen this perception and could exacerbate the shift away from a subsistence diet. Episodes of poor air quality associated with dust or emissions will pose a health hazard for some population subsets. Health benefits may be seen with increased income and employment, such as improved mental wellbeing and improved diet and nutrition, although economic growth and in-migration may also be associated with increased use and access to alcohol and drugs and the spread of infectious disease and sexually transmitted diseases. Benefits and risks will be	The focus on the protection of surface resources under Alternative B-1 will help preserve subsistence uses of the land and prevent associated adverse changes in public health. Less conflict between development and subsistence use than under Alternative A will further minimize the likelihood of environmental contamination and should reduce the likelihood of an exacerbation in the currently high levels of perceived contamination in the region and resulting health effects. The lower overall level of revenue and jobs compared with Alternatives C and D will lessen potential benefit from these areas, but will comparatively minimize the negative impacts of in-migration and economic growth.	Under Alternative B-2, the pattern of health impacts is likely to be similar to Alternatives A and B-1. However, the focus on the protection of surface resources under Alternative B-2, as with B-1, will help preserve subsistence uses of the land and prevent associated adverse changes in public health. Less conflict between development and subsistence use than under Alternatives A, C and D will further minimize the likelihood of environmental contamination and should reduce the likelihood of an exacerbation in the currently high levels of perceived contamination in the region and resulting health effects. The lower overall level of revenue and jobs compared with Alternatives C and D will lessen potential benefit from these areas, but will comparatively minimize the negative impacts of in-migration and economic growth. The addition of Best Management Practice A-12 for Alternative B-2 will help minimize potential adverse health outcomes compared with the other alternatives.	The greater level of oil and gas development land use may lead to a higher level of adverse changes in public health via changes in subsistence resources, use patterns, and perceptions of contamination than from Alternatives A, B-1, or B-2. Partial protections of special areas of surface resources under Alternative C, including the preclusion of production pads in the Teshekpuk Lake area, protections of calving and insect relief area for the Western Arctic caribou herd, and protections for the Colville River, will help protect subsistence activity and will reduce the likelihood and severity of health impacts resulting from changes in diet and nutrition.	The higher level of oil and gas activity possible under this alternative compared to the other alternatives may increase the likelihood and severity of health impacts resulting from changes in diet and nutrition as well as an increase in the health-related effects of rapid economic growth. If there is rapid and widespread expansion in oil and gas activity, public health is likely to be adversely impacted.

EFFECTS ON PUBLIC HEALTH

Alternative A (No-action Alternative)	Alternative B-1	Alternative B-2 (Preferred Alternative)	Alternative C	Alternative D
commensurate with the level of revenue, employment, road access, and the degree to which outside workers fraternize with local populations. The continued focus on the development of isolated work camps will temper adverse impacts.				
Cumulative Effects: Cumulative impacts on traditional culture and subsistence food systems may erode their protective effects on public health. Uncertainty over the impact of climate change on subsistence resources and related traditional lifestyles and culture combined with potential new conflicts in use of the Chukchi and Beaufort Seas is a cause of concern among Iñupiat hunters and community members. Climate change may also result in increased injury and trauma, as unusual or unpredictable weather, water, snow and ice conditions make travel more hazardous (Brubaker 2011) and people may travel greater distances to find marine or land mammals or edible plants. Westward extension of oil and gas activity may lead to more conflict and less successful or desirable use of traditional lands. Meanwhile, infrastructure associated with development, including roads, pipelines and new work camps, has the potential to more effectively import some of the negative social impacts associated with industrialization.				

Chapter 3:

Affected Environment

CHAPTER 3: AFFECTED ENVIRONMENT

3.1 Introduction

This chapter provides an overview of the physical environment, biological resources, and social systems that could be affected by the alternatives described in Chapter 2. The discussion of the physical environment and biological resources is largely limited to those resources that exist or spend part of their life in the NPR-A, or are otherwise closely linked to the resources of the NPR-A. The examination of the social systems includes communities inside and outside of the NPR-A that could potentially be impacted by the BLM's management actions within NPR-A. Where applicable, the sections include statements of trends in the natural environment, including those related to climate change. These trends, such as warming temperatures, greater precipitation, and a longer growing season, are derived from a variety of scientific studies, including one conducted by the Scenarios Network for Alaska and Arctic Planning specifically for this plan. A copy of the Network's summary report is included in Appendix C.

3.2 Physical Environment

3.2.1 Climate and Meteorology

The NPR-A is characterized as a northern polar climate (also known as the Arctic Zone), dominated by a lack of sunlight in the winter and long days in the summer. Winters are therefore long and cold, and summers are short and cool. The area has one of the harshest environments in North America, with relatively little precipitation. Monthly precipitation is fairly uniform, with slightly less in May and more in July and August. Streams and lakes are frozen for much of the year because of the long winter. Snow cover is common from October through May. Summers, while short and relatively cool near the coast, are longer and warmer inland. The onset of snowmelt and subsequent runoff often begins earlier in the foothills than in the rest of the area and moves north as the summer season progresses. Similarly, freeze-up usually begins first on the coastal plain and proceeds southward.

Although weather observations have been recorded at Barrow since 1917, there is a lack of historic monitoring within the planning area. The planning area includes all lands and only such lands as managed by the BLM within the NPR-A as described in Chapter 1, section 1.3. In addition, a range of spatial and temporal variations are likely to occur, dominated by proximity to waterbodies (e.g., the Arctic Ocean and Teshekpuk Lake), as well as local slope, aspect, and terrain. Within the Arctic Field Office Area, meteorological data are available from the remote automated weather station (RAWS) and the U.S. Geological Survey Permafrost and Climate Monitoring networks, as well as the cooperative weather station network. Table 3-1 provides a summary of temperature and precipitation conditions observed by cooperative weather observers at Umiat (1949–2001), at Barrow (1949–2009) on the north coast of the planning area, and at the Kuparuk Oil Field (1983–2009) to the east of NPR-A.

Table 3-1. Monthly climate summary

Umiat	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (F)	-12.7	-13.8	-6.7	11.5	32.4	57.5	66.2	57.7	41.4	18.2	-0.7	-11.9	19.9
Average Min. Temperature (F)	-28.9	-31.2	-26.8	-11	15.7	37	42.5	37.2	26.1	2.4	-16.8	-28	1.5
Average Total Precipitation (in.)	0.38	0.26	0.16	0.21	0.07	0.68	0.79	1.06	0.47	0.68	0.38	0.33	5.46
Average Total Snow Fall (in.)	4.5	2.4	2.3	1.9	1.2	0.2	0	0.2	2.6	8.5	5.2	4.2	33.2
Average Snow Depth (in.)	14	16	17	17	9	0	0	0	0	5	9	12	8
Kuparuk	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (F)	-11.1	-11.6	-8.2	8.5	28.3	47.4	55.9	50.6	39	21.3	3.5	-4.8	18.2
Average Min. Temperature (F)	-23.6	-24.4	-22.5	-6.5	16.9	33	38.8	36.7	28.8	10.6	-9.6	-17.8	5
Average Total Precipitation (in.)	0.12	0.17	0.08	0.15	0.07	0.34	0.88	1.05	0.49	0.35	0.15	0.13	3.98
Average Total Snow Fall (in.)	2.5	2.5	2.2	2.8	1.8	0.5	0	0.3	3.1	8.3	4.2	3.5	31.8
Average Snow Depth (in.)	8	8	9	9	5	0	0	0	0	3	6	7	5
Barrow WSO Airport	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (F)	-7.4	-11	-8	6.9	24.7	38.9	45.7	43.1	34.7	20.5	5.6	-4.6	15.8
Average Min. Temperature (F)	-19.8	-23	-20.6	-7	15.2	30	34	33.7	27.9	11.4	-5.6	-16.3	5
Average Total Precipitation (in.)	0.18	0.15	0.13	0.18	0.16	0.35	0.9	1.03	0.66	0.48	0.24	0.16	4.61
Average Total Snowfall (in.)	2.3	2.4	1.9	2.6	2.2	0.6	0.3	0.7	3.9	7.4	4	2.4	30.8
Average Snow Depth (in.)	9	10	11	11	6	1	0	0	1	4	7	8	6

Source: Western Regional Climate Center (2010)

The annual mean temperature in the NPR-A is about 10 °F, with subfreezing temperatures occurring from mid-October into May. Construction work and oil exploration are often conducted in winter because both the ground and the streams are frozen enough to allow the use of heavy equipment. February is the coldest month, with average maximum temperatures of -10 to -15 °F and average minimum temperatures of -25 to -30 °F. July is the warmest month, with average maximum temperatures of 45 to 65 °F and average minimum temperatures of 35 to 40 °F. Average snow depth from December through April is 10 inches in Barrow on the coast, and 15 inches in Umiat in the foothills. Snowfall is greatest in October, but can occur during any month of the year (Western Regional Climate Center 2010b, 2010c). Although wind measurements are rare, prevailing winds are expected to blow cold air off the frozen Arctic Ocean and are strongest during winter, often creating blizzard conditions. Southerly winds may occasionally break this pattern. The annual mean wind speed at Barrow Airport is approximately 12 miles per hour, with a measured sustained peak of 58 miles per hour in March 1960.

Wind data for 2009 from the Umiat RAWS station and for 2010 from the Nuiqsut Conoco-Phillips station are presented in Figure 3-1. Prevailing wind direction at Umiat was from the west, with wind speeds generally less than 8 miles per hour. Prevailing wind direction at Nuiqsut was from the northeast, with wind speeds averaging 11 miles per hour and a maximum wind speed of 45 miles per hour (Conoco-Phillips Alaska Inc. 2011). There is often very little or no wind at Umiat (Western Regional Climate Center 2010a).

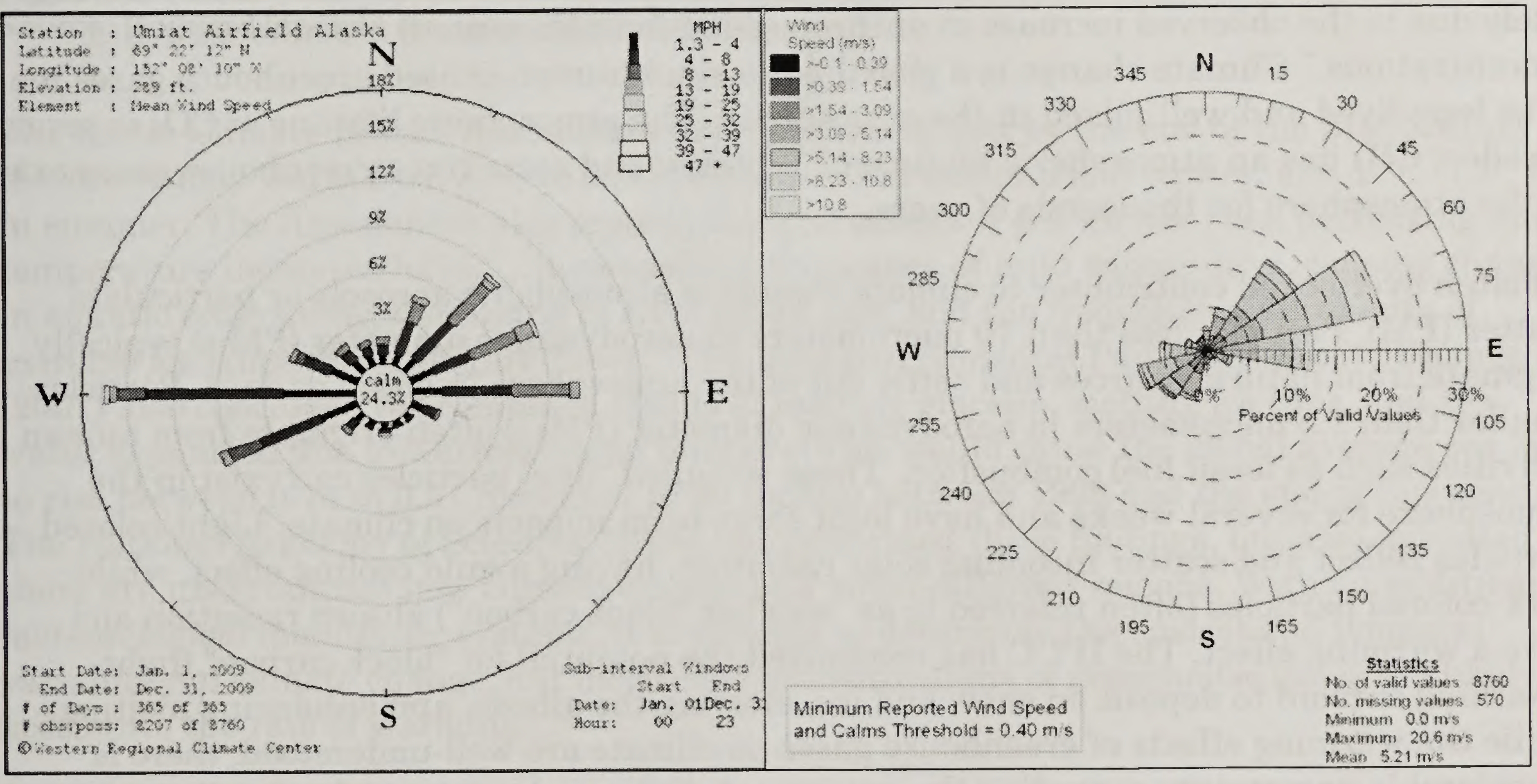

Figure 3-1. Umiat (left) and Nuiqsut (right) wind roses

3.2.1.1 Climate Change on the North Slope

The natural greenhouse effect refers to the process by which greenhouse gases (including carbon dioxide [CO_2], methane [CH_4], nitrous oxide [N_2O], water vapor, and several trace gases) in the atmosphere absorb heat energy radiated by earth's surface. These greenhouse gases trap heat that would otherwise be radiated into space and warm earth's atmosphere, making surface temperatures suitable for life on earth. Natural greenhouse gas concentrations in the atmosphere have varied for millennia and earth's climate has varied accordingly. However, beginning with the industrial revolution around the year 1750, human activities such as the burning of fossil carbon sources have increased greenhouse gas concentrations in the atmosphere dramatically. For example, from pre-industrial times until today, the global average concentration of CO_2 in the atmosphere has increased by around 39 percent (EPA 2012). In addition to climate impacts, increasing CO_2 concentrations lead to preferential fertilization and growth of specific plant species.

Global Warming Potential (GWP) is the value used to compare the abilities of different GHGs to trap heat in the atmosphere. GWPs are based upon the heat absorbing ability of each gas relative to carbon dioxide (CO_2). For example, methane gas (CH_4) has a GWP of 21, meaning it is 21 times more potent than CO_2. Fire, increased shipping, methane hydrate sources, melting ice, submarine landslide, and permafrost contribute to methane releases. Methane is also released during the oil and gas extraction process. The global average CH_4 concentration has increased by 158% since pre-industrial times (EPA 2012). For consistency and comparison purposes, greenhouse gas emissions are often reported in terms of carbon dioxide equivalent (CO_2 Eq).

The relationship between greenhouse gas emissions and climate change is in its formative phase, and it is not yet possible to know with confidence the net impact of human-caused GHG emissions on climate. However, the Intergovernmental Panel on Climate Change (IPCC 2007) concluded that "Warming of the climate system is unequivocal..." and "Most of the observed increase in globally average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic (human-caused) greenhouse gas concentrations." Climate change is a global issue since human-caused greenhouse gases tend to be long-lived and well-mixed in the atmosphere. The atmospheric lifetime of CO_2 is several decades; CH_4 has an atmospheric lifetime of 12 years; and some trace greenhouse gases exist in the atmosphere for thousands of years.

An often overlooked contributor to climate change is atmospheric aerosols or particulate matter (PM). Particles less than 10 micrometers in aerodynamic diameter (PM_{10}) typically originate from natural sources and settle out of the atmosphere in hours or days. Particles smaller than 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$) often originate from human activities such as fossil fuel combustion. These so-called "fine" particles can exist in the atmosphere for several weeks and have local short-term impacts on climate. Light-colored particles reflect and scatter incoming solar radiation, having a mild cooling effect, while dark-colored particles (often referred to as "soot" or "black carbon") absorb radiation and have a warming effect. The IPCC has recognized the potential for "black carbon" (light-absorbing carbon) to deposit on snow and ice, altering the albedo, and enhancing melting. While the warming effects of greenhouse gases on climate are well-understood, there is considerable uncertainty regarding the net impact of atmospheric particles on climate.

Global mean surface temperatures increased by 1 °C or 1.8°F from 1890 to 2006 (Goddard Institute for Space Studies 2007). Figure 3-2 demonstrates that northern latitudes (above 24 °N, which includes all of the continental United States) have exhibited temperature increases of nearly 1.2 °C (2.1 °F) since 1900, with nearly a 1 °C (1.8 °F) increase since 1970 alone. It is anticipated that global average surface temperatures will increase by 1.4 to 5.8 °C (2.5 to 10 °F) above 1990 levels by 2100 (IPCC 2007). However, climate change will impact regions differently and increases in temperature will not be equally distributed. Both observations and computer model predictions indicate that increases in temperature are likely to be greater at higher latitudes, such as in the Arctic, where the temperature increase may be more than double the global average.

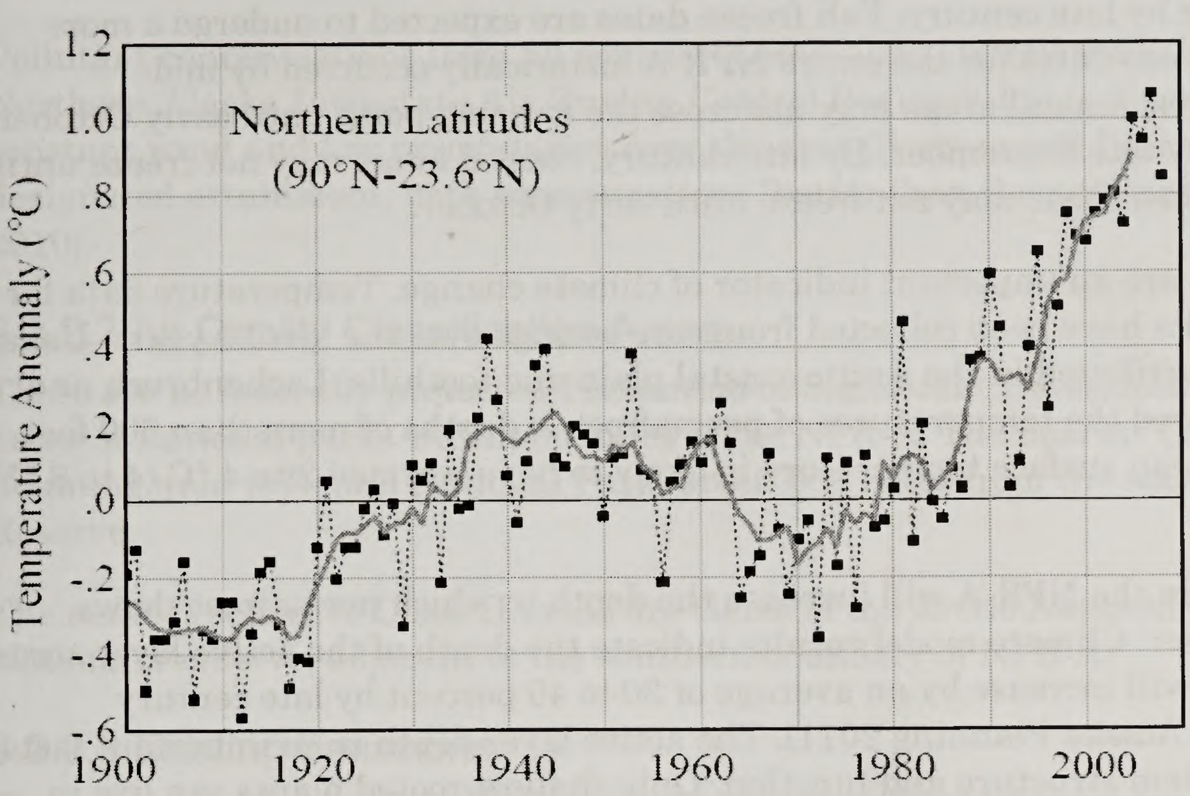

Figure 3-2. Annual mean temperature change for northern latitudes (24-90 °N). Source: Goddard Institute for Space Studies (2007).

The Arctic Climate Impact Assessment (2005) predicts that by the end of the 21st century the Arctic may warm from 3 °C to 5 °C (5.4 to 9 °F) in autumn and winter, and 1 °C (1.8 °F) in summer. The Assessment also reports that the extent of sea ice has been decreasing and temperature increases have "...increased the frequency of mild winter days, causing changes in aquatic ecosystems; the timing of river break-ups; and the frequency and severity of extreme ice jams, flood, and low flows." The Intergovernmental Panel on Climate Change (2007) also concluded the combined effects of melting glaciers, melting ice caps, and sea water expansion due to warmer ocean temperatures would cause the global average sea level to rise between 0.18 to 0.51 meters (7 to 20 inches) between 1999 and the end of this century. The National Academy of Sciences (2006) has confirmed these findings, but also indicated there are uncertainties how climate change will affect different regions. Without additional meteorological monitoring systems, it is difficult to determine the spatial and temporal variability of climate change, but increasing concentrations of greenhouse gases are likely to accelerate the rate of warming.

Similarly, the Scenarios Network for Alaska Planning (2011) predicts increasing temperatures and precipitation in the NPR-A. Average summer temperatures are expected to increase by 3 °F by the 2040s and 6 °F by the 2090s. Summer precipitation is projected to increase 1.2 inches by the 2040s and 1.6 inches by the 2090s. Average winter temperatures may increase by 11 °F by the 2040s and as much as 18 °F by the 2090s. Winter precipitation is projected to increase 1.6 inches by the 2040s and 2.7 inches by the 2090s. Summer temperature increases are expected to be greatest in the mountains and less extreme in the coastal plain. The opposite pattern is predicted for the winter.

The time period between the dates at which the freezing point is crossed in the spring and fall defines the summer season. Climate change is expected to increase the length of the summer season in the NPR-A by between three and six weeks (Scenarios Network for Alaska Planning 2011). Spring thaw dates are expected to shift one week earlier by mid-century and up to two weeks earlier by late century. Fall freeze dates are expected to undergo a more extreme transition. Freeze dates for the entire NPR-A historically occurred by mid-September. By the 2040s, coastal areas may not cross the freezing point until early October and southern regions by late September. By late century, coastal areas may not freeze until late October and southern areas may not freeze until early October.

Changes in permafrost are an important indicator of climate change. Temperature data for the permafrost in Alaska have been collected from core borings over the last 20 years. Using oil exploration wells distributed in the Arctic coastal plain and foothills, Lachenbruch and Marshall (1986) measured the temperatures of permafrost to depths of more than 600 feet and showed that the mean surface temperature is likely to have warmed 2 to 4 °C (4 to 8 °F) during the last century.

Warmer temperatures in the NPR-A will increase the depth to which permafrost thaws, known as the active layer. Climate model results indicate the depth of the active layer across all areas of the NPR-A will increase by an average of 30 to 40 percent by late century (Scenarios Network for Alaska Planning 2011). The active layer depth is an important factor that determines ecosystem structure and function. Only shallow-rooted plants can live in areas with a shallow active layer, while deeper-thawed soils permit better water drainage and the growth of woody plants. Loss of permafrost can also cause thermokarst, slumping, and other significant changes in land morphology.

Northern latitudes have experienced significant warming over the last half-century and some impacts of climate change are already visible in Alaska. These impacts include coastal erosion, increased storm effects, retreat of sea ice, and melting of permafrost (Hassol 2004). Other anticipated effects include changes in wildfire patterns and changes in species abundance and diversity. The Alaskan villages of Shishmaref, Kivalina, and Newtok have begun relocation plans. The U.S. Army Corps of Engineers has identified over 160 other rural communities threatened by erosion (Alaska 2012).

Many of these climatic changes concern residents of the North Slope of Alaska who utilize the area for subsistence purposes (Alaska Native Science Commission and the Institute of Social and Economic Research 2007). The Barrow Arctic Science Consortium opened its Barrow Global Climate Change Research Facility in 2007 to facilitate future research into climate change issues, including atmospheric, oceanic, hydrologic, and social studies.

3.2.2 Air Quality

This section describes attainment status (regulatory compliance with standards), air quality classification areas (including Prevention of Significant Deterioration Class I and sensitive Class II areas), existing emissions, and existing air quality.

3.2.2.1 Attainment Status

The NPR-A is in an area that is in attainment of current National Ambient Air Quality Standards and the Alaska Ambient Air Quality Standards, which are the same for all criteria pollutants (Table 3-2 on page 146). In addition, the State of Alaska is in the process of updating regulation 18 AAC 50 to include a 24-hour standard for fine particulates (particles with diameters less than or equal to 2.5 microns [$PM_{2.5}$]). Once the regulation is updated a determination of compliance will be made.

Pollutant concentrations from all sources of emissions are relatively low throughout the Northern Alaska Intrastate Air Quality Control Region 9 due to dispersion caused by nearly constant wind and low precipitation over the area (Serreze and Barrett 2011). The area is designated attainment, with concentrations "better than the national standards" (40 CFR 81, 2010).

3.2.2.2 Air Quality Classification Areas

There are no federally protected Prevention of Significant Deterioration Class I wilderness areas or national parks within 60 miles of the NPR-A. The nearest Class I area to the planning area is Denali National Park, about 350 miles from the southern boundary of the Reserve.

The nearest sensitive Class II areas are Gates of the Arctic National Park and Noatak National Preserve, adjacent to the southern boundary of NPR-A.

3.2.2.3 Existing Emissions

The air quality in the Colville River Delta is generally good as a result of few pollution sources and good dispersion created by frequent winds and neutral to unstable conditions in the lower atmosphere. Windblown dust tends to occur more in the summer months as sandbars dry along the riverbeds in the Colville River Delta, resulting in temporary increases in concentrations of particulate matter. Emission sources in the planning area consist mainly of diesel-fired generators in small villages, residential heating, snow machines, all-terrain vehicles, occasional small aircraft, limited local vehicle traffic, and occasional open burning. Regional sources of emissions consist of oil and gas production facilities east of the NPR-A, including Kuparuk, Milne Point, Prudhoe Bay, North Star, Endicott, and Alpine Fields. Emissions sources at the Alpine field production and drilling areas just to the east of the planning area in the Colville River delta include gas-fired turbines and heaters, incinerators and flaring, diesel-fired power generators, storage tanks, fugitive hydrocarbon emissions, and mobile sources (vehicle traffic and aircraft).

Average annual criteria air pollutant emissions for the North Slope Borough for 2002 (EPA 2010) have been reported as follows (in tons per year): Carbon monoxide (CO), 20,279; nitrogen dioxide (NO_2), 41,924; Fine Particulate Matter ($PM_{2.5}$) - 382; Particulate Matter (PM_{10}) – 1,841; Sulfur Dioxide (SO_2) - 923; and volatile organic compounds (VOC), 1,937. During 2002 (EPA 2010), emissions of all 188 hazardous air pollutants amounted to 400,692 pounds. Seven specific hazardous air pollutants (benzene, toluene, ethylbenzene, xylenes, formaldehyde, hexane, and 2,2,4-trimethylpentane) accounted for 79 percent of these total emissions. The largest source of emissions was fuel combustion by industrial facilities (EPA 2010).

3.2.2.4 Air Quality

Air quality includes air pollutant concentrations and air quality-related values, such as atmospheric deposition and visibility.

Air Pollutant Concentrations

Air pollutant concentration usually refers to the mass of pollutant present in a volume of air. EPA has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants, and are described in Table 3-2. Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air (μg/m^3). The State of Alaska Ambient Air Quality Standards are the same as the National Ambient Air Quality Standards.

Table 3-2. Applicable federal Ambient Air Quality Standards and State of Alaska Ambient Air Quality Standards

Pollutant final rule citation		Primary/ secondary	Averaging time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3 month average	0.15 μg/m^3 (1)	Not to be exceeded.
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010]		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
[61 FR 52852, Oct 8, 1996]		primary and secondary	Annual	53 ppb (2)	Annual Mean.
Ozone [73 FR 16436, Mar 27, 2008]		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years.
Particle Pollution [71 FR 61144, Oct 17, 2006]	$PM_{2.5}$	primary and secondary	Annual	15 μg/m^3	Annual mean, averaged over 3 years
			24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years.
[38 FR 25678, Sept 14, 1973]		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year.

(1) Final rule signed October 15, 2008. The 1978 lead standard (1.5 μg/m3 as a quarterly average) remains in effect until 1 year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

(2) The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

(3) Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

(4) Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

An ambient air quality monitoring station has operated at Nuiqsut since April 1999, originally as a State of Alaska permit condition for the Alpine field. The condition required collection of at least 1 year of ambient nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter less 2.5 microns in diameter ($PM_{2.5}$), particulate matter less than 10 microns in diameter (PM_{10}), and meteorological data. Data collected at Nuiqsut are believed to be representative of background air quality in the Alpine field area except for particulates since all roads in Nuiqsut are dirt and particulates become airborne from normal road and off-highway vehicle traffic. Data from 2010 indicate that gaseous air pollutants and both $PM_{2.5}$ are well within the Alaska Ambient Air Quality Standards. There was one day when the PM_{10} concentration was slightly higher than the 24-hour standard. All observations suggest that the source of the high PM_{10} value on October 2 was local fugitive dust as there was no snow on the ground and winds were averaging 22 mph (Figure 3-3).

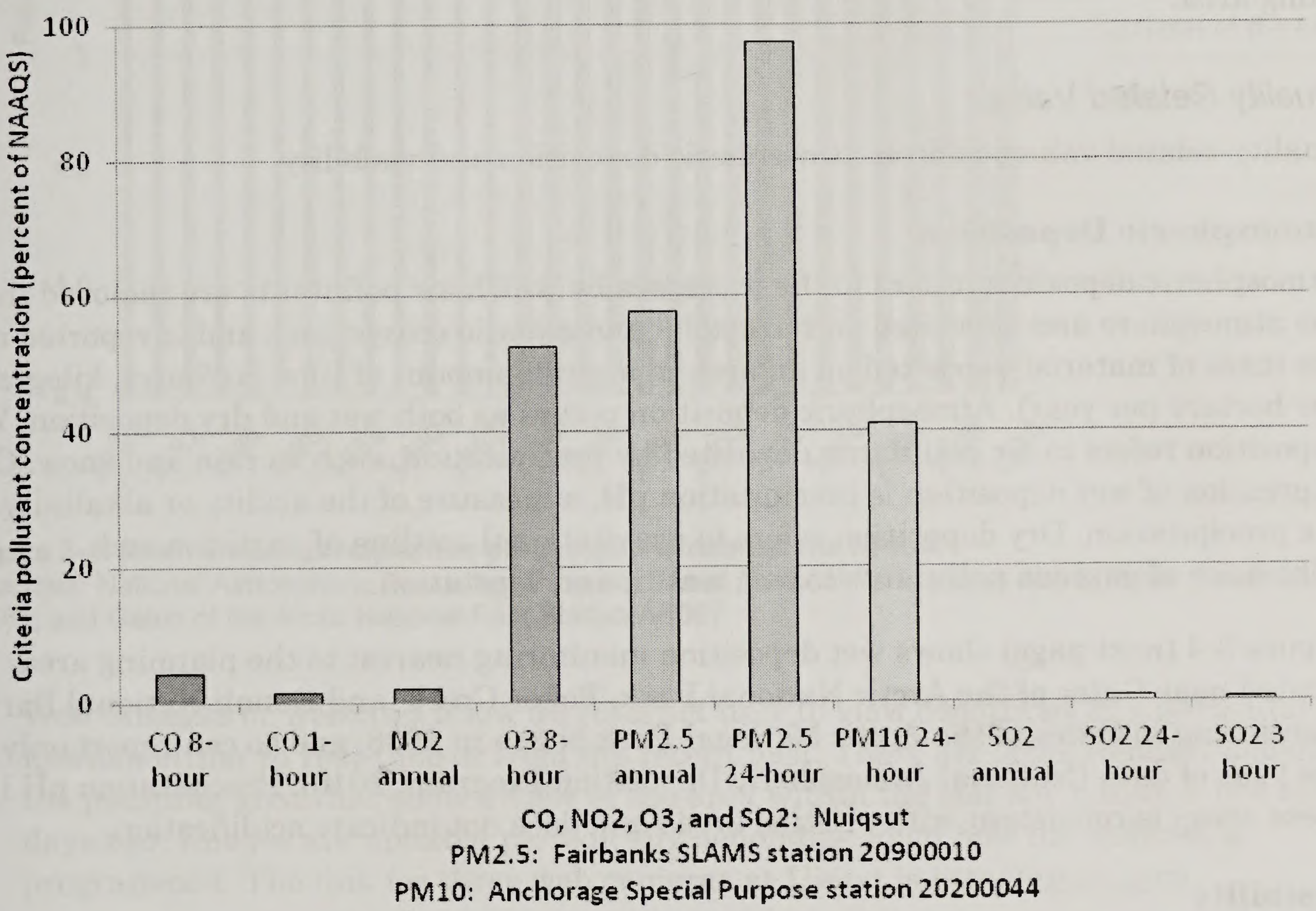

Figure 3-3. Background concentrations of criteria pollutants, 2010

These data indicate that air quality is in compliance with both the National Ambient Air Quality Standards and the Alaska Ambient Air Quality Standards for all pollutants and averaging periods. Although one day of high PM_{10} concentrations also occurred in 1999 as a result of wind-generated dust, this did not constitute a violation of the standards. Both federal and State regulations exclude natural events, and even man-made events are permitted to exceed the 24-hour particulate matter standard a few days each year (18 AAC § 50.010, Title 18 Environmental Conservation, Chapter 50, Air Quality Control Article 1, Ambient Air Quality Management). Air pollutants currently monitored at Nuiqsut are ozone, carbon monoxide, oxides of nitrogen, nitric oxide, sulfur dioxide, and particulates (both PM_{10} and $PM_{2.5}$). In addition, trace amounts of air pollutants, including metals, have been detected in vegetation at very low levels, and arctic haze is periodically observed on the North Slope, due primarily to air pollutant emissions originating in northern Europe and Asia (and to a lesser extent, northern Alaska).

Local residents have expressed concerns regarding air quality impacts from fine particulate matter and hazardous air pollutants emitted during oil and gas development. However, as described by the National Research Council (2003), "Little research has been done to quantify the effects of air pollution on the North Slope or to determine how local and regional air masses interact. Air pollution monitoring has been limited to priority pollutants from 1986 through 2002 at a few sites. Not enough information is available to provide a quantitative baseline of spatial and temporal trends in air quality over long periods across the North Slope." More recent studies are not available. Regulatory concentration monitoring nearest to the NPR-A is located in Fairbanks, and is unlikely to be representative of the planning area.

Air Quality Related Values

Air quality-related values include atmospheric deposition and visibility.

Atmospheric Deposition

Atmospheric deposition refers to the processes by which air pollutants are removed from the atmosphere and deposited on terrestrial and aquatic ecosystems, and is reported as the mass of material deposited on an area in a given amount of time (kg/ha-yr, kilogram per hectare per year). Atmospheric deposition occurs as both wet and dry deposition. Wet deposition refers to air pollutants deposited by precipitation, such as rain and snow. One expression of wet deposition is precipitation pH, a measure of the acidity or alkalinity of the precipitation. Dry deposition refers to gravitational settling of particles and adherence of gaseous pollutants to soil, water, and vegetation.

Figure 3-4 (next page) shows wet deposition monitoring nearest to the planning area, located near Gates of the Arctic National Park, Poker Creek, and Denali National Park. Monitoring in Gates of the Arctic National Park began in 2008, and so can report only one year of data (National Atmospheric Deposition Program, 2010). Precipitation pH in these areas is consistent with pristine areas and does not indicate acidification.

Visibility

Visibility can be defined as the ability to see color, texture, and contrast at a distance and can be reported as visual range, in units of distance such as miles. Visibility can be addressed by scene monitoring (producing images with a camera) or more fully by optical and chemical analyses (such as the Integrated Monitoring of Protected Visual Environments (IMPROVE) network).

The IMPROVE visibility monitoring stations nearest to the NPR-A are in Bettles (about 20 miles south of Gates of the Arctic National Park) and in Denali National Park. Monitoring in Bettles began in 2008, and cannot yet provide visibility data. The Denali station 350 miles away, and is unlikely to be representative of the planning area. Visibility in Denali is consistent with pristine areas, and has stayed about the same since monitoring began in 1988 (IMPROVE 2010).

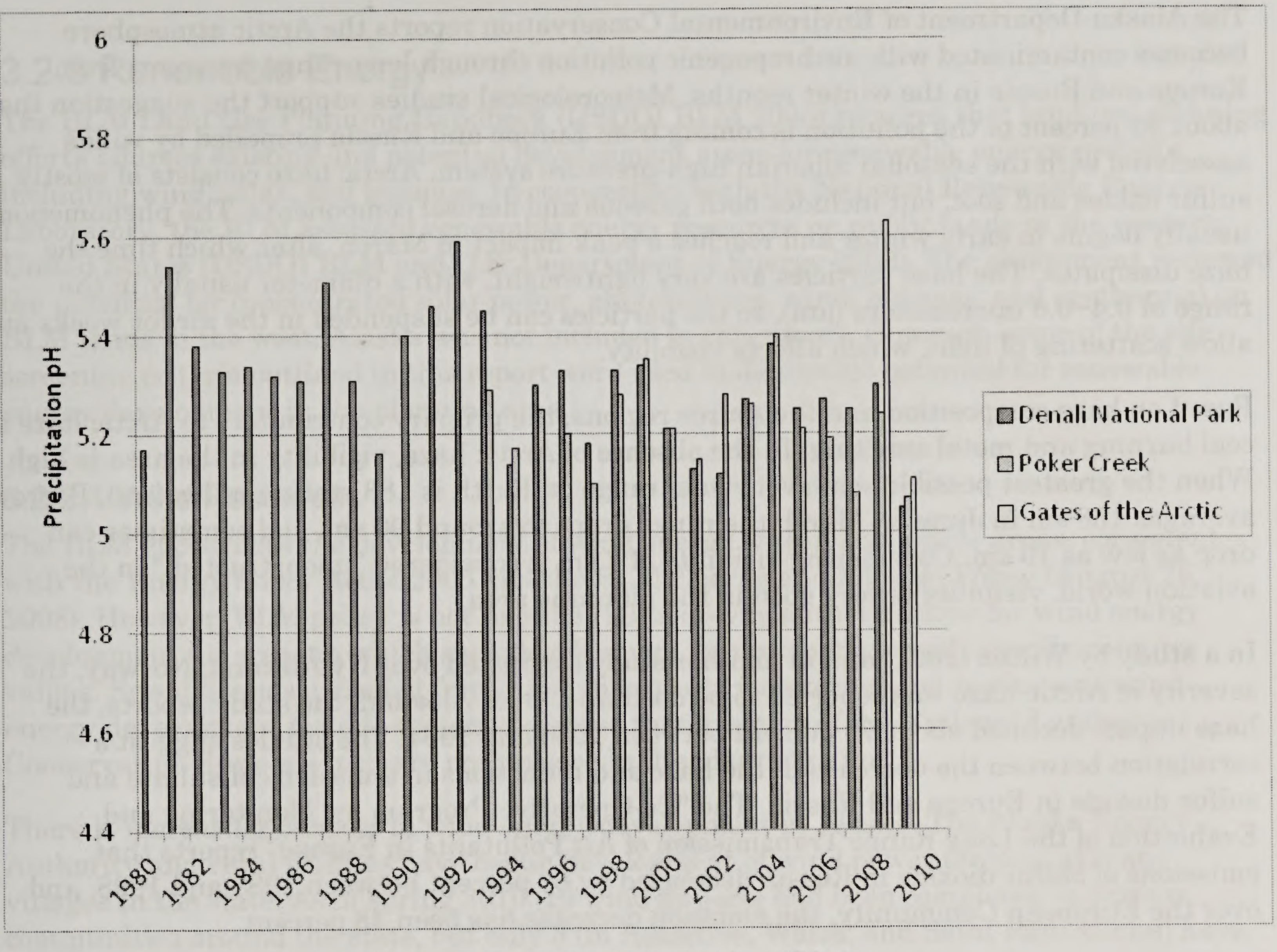

Figure 3-4. Mean annual precipitation pH at stations nearest the NPR-A
(Sources: National Atmospheric Deposition Program Denali National Park Station AK03, Poker Creek Station AK01, and Gates of the Arctic National Park Station AK06)

Web cameras or webcams allow an Internet user to view conditions at a particular location either in real-time or from the recent past. There are some webcam websites in the planning area that show a view of the area within the last few minutes, few hours, or days ago. Images are updated periodically depending upon how the webcam is programmed. The link for three web cameras at Umiat is http://umiat.com.

3.2.2.5 Air Quality and Climate Change

The EPA has determined the regional air quality over Air Quality Control Region 9 continues to be better than the National Ambient Air Quality Standards even with the seasonal occurrence of Arctic haze (EPA 2010a). The wind becomes the long-range transport mechanism of anthropogenic pollution from sources on the Eurasian continent during the winter and early spring. These emissions are primarily sulfate aerosols and result in a phenomenon referred to as "Arctic haze."

The area is designated attainment, with concentrations "better than the national standards." Regardless of the occasional Arctic haze, the EPA considers this area compliant with the National Ambient Air Quality Standards.

The Alaska Department of Environmental Conservation reports the Arctic atmosphere becomes contaminated with anthropogenic pollution through long-range transport from Europe and Russia in the winter months. Meteorological studies support the suggestion that about 95 percent of the pollution is coming from Europe and Russia propelled by winds associated with the seasonal Siberian high-pressure system. Arctic haze consists of mostly sulfur oxides and soot, but includes both gaseous and aerosol components. The phenomenon usually begins in early winter and reaches a peak impact in March, after which time the haze dissipates. The haze particles are very lightweight, with a diameter usually in the range of 0.4–0.8 micrometers (µm), so the particles can be suspended in the air for weeks and allow scattering of light, which affects visibility.

Based on haze composition and the source regions, the primary contributors to Arctic haze is coal burning and metal smelting. In the absence of Arctic haze, visibility in the area is high. When the greatest possible sea-level visual range on Earth is 183 statute miles (sm), Barrow averages 168 sm in June; in March the range drops to around 90 sm, and sometimes can drop as low as 19 sm. Considering visibility of 7 sm is considered "unobstructed," in the aviation world, visibility is very good in the planning area.

In a study by Wilcox (2001) and in another study conducted over Ny Ålesund, Norway, the severity of Arctic haze was reported to be declining. Over Ålesund, the study reports, the haze impact declined about 70 percent between 1980 and 1994. The studies suggest a correlation between the decrease in the haze and reductions in emissions of sulfate and sulfur dioxide in Europe and Russia. The "Co-Operative Program for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe" reports that emissions of sulfur dioxide in Russia decreased by 61 percent between 1988 and 1998, and over the European Community, the emission decrease has been 48 percent.

A 2008 report in the "Moscow News" changed the projected timeframe of increased coal-burning in Russia to 2020. Rosner (2009) reports the recent global economic recession only slowed Russia's schedule to increase coal burning. Russia's Energy Strategy suggests the country will supplant natural gas power with coal through 2030. An article in the Alaska Science Forum (UA 2009) also reached the same conclusion of declining Arctic haze impacts. The University of Alaska-Fairbanks, Geophysical Institute stated that Arctic haze is disappearing, but does not definitively state the cause of the decline over the last 30 years, although decreasing emissions of smelting in Russia and improved emission technology is mentioned.

Fires occurring either naturally or man-made in the Arctic region could also contribute to Arctic haze. The Scenarios Network for Alaska Planning (2010) fire map projects that fires would be more frequent in the southern part of the NPR-A by the 2090s. The potential for more fire would increase air quality impacts for particulates, carbon monoxide, oxides of nitrogen, and volatile organic compounds. With warmer winters projected by the 2040s, winter travel may be reduced due to less snow cover and local boat traffic may be reduced due to lower water levels. This would reduce air pollution emissions from these modes of transportation.

3.2.3 Renewable Energy

The BLM Land Use Planning Handbook (USDOI BLM 2005) requires that land use planning efforts address existing and potential development areas for renewable energy projects, including wind, solar, and biomass. In cooperation with the National Renewable Energy Laboratory, the BLM assessed renewable energy resources on public lands in the western United States (USDOI BLM and U.S. Department of Energy 2003). The assessment reviewed the potential for concentrated solar power, photovoltaics, wind, biomass, and geothermal on BLM lands in the west. Alaska was not included in this report. However, some of the site screening criteria outlined in this report were used to determine potential for renewable energy development in the planning area.

3.2.3.1 Wind Resources

The BLM encourages the development of wind energy within acceptable areas, consistent with the Energy Policy Act of 2005 and the BLM Energy and Mineral Policy (August 26, 2008). However, BLM policy is not to issue rights-of-way authorizations for wind energy development for areas in which such development is incompatible with specific resource values. Specific lands excluded from wind energy site monitoring and testing and wind energy development include designated areas that are part of the National Landscape Conservation System which are not present in the planning area.

There is increasing interest in wind energy development in Alaska. The Alaska Energy Authority and rural utilities have begun development of wind power projects at many villages in the state. As of spring 2010, 19 wind projects had been completed in various communities around the state, but only 3 (in Kotzebue, Wales, and Saint Paul Island) have been operating for more than a few years. The total installed capacity in these projects is approximately 11,856 kW, from an investment of about $82 million (Faye et al. 2010)

The BLM's Anchorage Field Office has received applications for wind turbine towers. The Department of Energy's Wind Program and National Renewable Energy Laboratory has published a wind resource map for Alaska[5] which shows wind speed estimates at 50 meters above the ground and depicts the resource that could be used for utility-scale wind development.

As a renewable resource, wind is classified according to wind power classes, which are based on typical wind speeds. These classes range from Class 1 (the lowest) to Class 7 (the highest). In general, at 50 meters, wind power Class 4 or higher can be useful for generating wind power with large turbines and are considered good resources. Particular locations in the Class 3 areas could have higher wind power class values at 80 meters than shown on the 50-meter map because of possible high wind shear. Given the advances in technology, some locations in Class 3 areas may be suitable for utility-scale wind development. Primary criteria for wind development outlined in the "Assessing the Potential for Renewable Energy on Public Lands" (BLM and U.S. Department of Energy 2003) included a wind power Class 4 and above for short term, and Class 3 and above for long term; and transmission access within 25 miles and road access within 50 miles.

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[5] http://www.windpoweringamerica.gov/maps_template.asp?stateab=ak

Within the planning area, wind potential is generally poor to fair (Class 1–3), though generally higher near the coast. The following sites within or adjacent to the planning area were analyzed by the Alaska Energy Authority for their wind potential: Umiat, Class 1; Barrow, Wainwright, and Deadhorse, Class 4; Point Hope, Class 6; and Kuparuk, Class 7.

The potential to use wind as a supplemental energy source for local communities located along the coast within the planning area is high. According to the U.S. Department of Energy, the coastal areas of northwestern Alaska have excellent potential for wind energy (U.S. Department of Energy 2001). Many smaller communities in the planning area rely on diesel-powered generating stations and the cost of generating electricity in this manner is very high. Using wind turbines along with diesel generation can save significant amounts of fuel. To be effective, sites, need to be close to communities. Most of the land around villages is owned by Native corporations and the BLM manages very little land adjacent to communities or near existing transmission lines. Additionally, most BLM-managed land in the planning area generally has only poor to fair wind potential (U.S. Department of Energy 2006). Thus, the potential for communities to use BLM-managed lands for local generation of wind energy is low.

Small wind turbines are presently supplying remote meteorological stations at Ivotuk, Umiat, and Inigok with power to recharge battery banks. Wind power provides a critical source of power during the darkest months of November through January when solar energy is insufficient to charge battery banks.

3.2.3.2 Solar

The potential for commercial solar operations is very low. One of the criteria outlined in "Assessing the Potential for Renewable Energy on Public Lands" (BLM and U.S. Department of Energy 2003) is a solar resource of at least 5 kilowatt hours per square meter per day. This criteria is not met anywhere within the planning area (U.S. Department of Energy 2008a and 2008b). Small-scale solar panel arrays are commonly utilized by remote weather and gauging stations within the planning area. The smaller stations typically have sufficient storage capacity to continuously operate during extended periods of no sunlight. Larger meteorological stations also rely on small wind generators and diesel generators to charge battery banks when solar power is unavailable.

3.2.3.3 Biomass

The biomass program is the use of organic matter waste products for production of products such as paper and pulp, value-added commodities, and bio-energy or bio-based products such as plastics, ethanol, or diesel. Alaska's most important biomass fuels are wood, sawmill wastes, fish byproducts, and municipal waste (Alaska Energy Authority 2009[6]).

The potential for the use of biomass from public lands within the planning area is extremely limited. Most BLM-managed lands are remote, difficult to access, and too far from population centers to make use of biomass economical. Fuel reduction projects adjacent to villages are a likely source of biomass fuels but no vegetative treatments have been conducted in the past and the probability of future treatments on BLM-managed land is low.

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[6] http://www.akenergyauthority.org/programsalternativebiomass.html

3.2.3.4 Geothermal

Alaska has a number of documented shallow sources of heat along its southern margin and in the central part of the state. For physical and economic reasons many of these resources are under-explored and undeveloped. These known geothermal areas range from modest temperature thermal springs like Pilgrim, Chena, and Manley to large areas of hot springs found on or near active volcanoes. The locations of all major thermal springs in Alaska have been identified, but some lack basic descriptive information such as flow rate and geochemistry. There are no known geothermal sites in Alaska north of the Brooks Range (BLM 2008).

There are numerous sedimentary basins in Alaska, the most famous of which underlies the North Slope and hosts the Prudhoe Bay oilfield. Excellent porosity and permeability can be maintained in sedimentary rocks at depth, and if the geothermal gradient is sufficient, hot fluid can be produced from these formations. For example, the reservoir temperature at Prudhoe Bay at 7,500 to 8,000 foot depth is approximately 180 to 200 °F. Depending on the geothermal gradient of the basin and the relic permeability at depth, production of this hot water may become a viable small-scale energy source for oilfield operations, or even for communities in the immediate area. The high cost of drilling and permeability enhancement, along with relatively low geothermal temperatures, makes these resources difficult to economically develop on a stand-alone basis (Alaska Energy Authority 2009).

3.2.4 Physiography

Physiography can be described as the classification of large-scale landforms within a given area. The NPR-A planning area contains three major physiographic regions of Alaska: the Arctic Coastal Plain, Arctic Foothills, and the Arctic Mountains (Wahrhaftig 1965; Map 3.2.4-1). The planning area is a high-latitude arctic environment. Throughout the three physiographic provinces in the planning area there are no glaciers and the entire area is underlain by continuous permafrost.

3.2.4.1 Arctic Coastal Plain Province

The Arctic Coastal Plain Province covers approximately 46 percent of the planning area. It is a smooth plain rising imperceptibly inland between roughly 15 to 100 miles from the coast of the Arctic Ocean (Wahrhaftig 1965). The coastline is irregular and contains many small bays, lagoons, spits, beaches, and barrier islands (National Research Council 2003). The Arctic Coastal Plain is dominated by periglacial features (e.g., thaw lakes, marshes, and polygonal patterned ground) that provide little topographic relief and poor drainage. Polygonal-patterned ground forms from ice wedges that freeze within contraction cracks of the soil. Throughout the year, these cracks fill with water and snow, then freeze and expand. During the warmer months, the surface ice melts and water remains. This process repeats annually, resulting in a polygonal-patterned surface. The lowlands are a flat vast treeless area of tundra, meandering streams, drained and undrained lagoons, and thousands of shallow thaw lakes. Freshwater lakes cover approximately 20 percent of the Arctic Coastal Plain lying within the planning area. Throughout most of the planning area, lakes are oriented north-northwest due to the effects of predominant winds on the permafrost shorelines of thaw lakes (Gallant et al. 1995). The little topographic relief on the Arctic

Coastal Plain is partially caused by large broad-based low hills or "pingos" created by permafrost (Walker et al. 1985).

On the eastern side of the planning area, the lake-filled coastal plain fades into an area of large, rounded lakes and numerous very small lakes at an elevation of about 100 feet above mean sea level and about 40 miles inland. Northeast-trending sand dunes, 3 to 6 meters high, such as the Pik Dunes, occur between the Kuk and Colville Rivers (Gallant et al. 1996).

3.2.4.2 Arctic Foothills Province

The Arctic Foothills Province consists of a wide swath of rolling hills and plateaus that grade from the coastal plain on the north to the Brooks Range on the south (Gallant et al. 1996). The foothills make up 51 percent of the NPR-A planning area. Elevations start at about 500 feet. The Arctic Foothills Province consists of tundra-covered rolling hills, and low east-west trending ridges. Quintessential east-west ridges occurring in the western part of the planning area include the 30-mile long Archimedes Ridge at 1,500 feet elevation and Lookout Ridge at 1,600 feet. The hills and valleys of the foothills region have better defined drainage patterns than those found in the coastal plain to the north and have fewer lakes (Gallant et al. 1996). In fact, waterbodies in the Arctic Foothills Province cover only approximately 1 percent of the foothills province (NHD 2007). Acting as the southern boundary for part of the planning area, the Colville River is the longest river in the Arctic Foothills Province at 220 miles long. The Colville flows from west to east for a majority of its course, turning north in its lowest 80 miles to reach the Arctic Ocean.

3.2.4.3 Arctic Mountains Province

The Arctic Mountains Province described by Wahrhaftig flanks the southern-most edge of the NPR-A from the Continental Divide north where creeks and rivers flow through the planning area. The Arctic Mountain Province represents 2 percent of the total NPR-A planning area and marks an increase in mountainous terrain with rugged ridges and elevations reaching 4,000 to 4,500 feet at the Continental Divide. The planning area includes some of the highest peaks in the DeLong Mountains around Nucleus, Thunder, and Sphinx mountains. Rubble and exposed bedrock cover the mountain slopes (Gallant et al. 1996). Many passes about 3,500 feet in altitude cross the range (Wahrhaftig 1965). Lakes are sparse in this area (Gallant et al. 1996) and cover less than 1 percent of this province in the planning area (NHD 2007).

3.2.4.4 Physiography and Climate Change

Northern environments, including the NPR-A planning area, have experienced warming over the last half-century (Scenarios Network for Alaska Planning 2008). This trend is expected to continue as climate models predict that high northern latitude regions will experience the greatest warming temperatures of the globe (IPCC 2007), trends that are reflected in climate change modeling conducted for the planning area by the Scenarios Network for Alaska Planning group at the University of Alaska-Fairbanks (Scenarios Network for Alaska Planning 2010).

The physical science working group to the IPCC highlighted the increasing temperature of northern hemisphere permafrost (Lemke et al. 2007). Permafrost degradation, the decrease in thickness and/or areal extent of permafrost, is anticipated within the planning area

(Lemke et al. 2007). The Arctic Coastal Plain Province, dominated by features and processes driven by permafrost, has the potential to change greatly with the anticipated degradation and thaw of permafrost. As near-surface permafrost melts and thaws, it creates an irregular landscape referred to as thermokarst (Hinkel et al. 2007). Scenarios Network for Alaska Planning models of permafrost in the planning area project that the mean annual thickness of the active layer of permafrost within the Arctic Coastal Plain will increase from 0.380 meters thick in the 1980s to 0.453 meters thick in the 2040s (Scenarios Network for Alaska Planning 2010). Increases in permafrost active layer depth are similarly expected for the foothill and mountains provinces, from 0.589 to 0.705 meters and 0.704 to 0.854 meters, respectively, when comparing the 1980s to 2040s (Scenarios Network for Alaska Planning 2010).

Along the Arctic coastline, erosion and shoreline retreat is also expected to accelerate in the changing northern climate as storms with storm surges are anticipated to be stronger and more frequent (Proshutinsky 2010). Lemke et al. (2007) identified coasts with ice-bearing permafrost exposed to the Arctic Ocean as the most sensitive regions of permafrost degradation. Jones et al. (2009) found that mean annual erosion rates north of Teshekpuk Lake increased from 6.8 meters per year in 1955 to 1979 to 13.6 meters per year in 2002 to 2007. Jones et al. (2009) further looked at different shoreline types and discovered the greatest increase in recent (2002–2007) erosion of ice-rich upland terrain, "suggesting a fundamental shift in the processes driving and resisting erosion." Localized extreme coastal erosion has been measured by specialists within the Arctic Field Office. In the 2004 season, the shoreline at the J.W. Dalton #1 test well receded over 320 feet inland (Flora 2005). Almost 1,500 feet of shoreline loss has occurred at this site since 1979 when the well was drilled (Flora 2005).

Of particular interest are the impacts of climate change to the numerous freshwater lakes of the Arctic Coastal Plain. Investigations of abundance or net surface area change in lakes have been conducted recently by several researchers; however, results have been mixed (Hinkel et al. 2007). Hinkel et al. (2007) summarize that some researchers have found lake expansion and growth, while others have found lake shrinkage or disappearance. Smith et al. (2005) found that lake expansion prevailed in the continuous permafrost zone of western Siberia and attributed the lake expansion to thermokarst landscape development.

Climate change within the planning area may cause vegetation and fire regime changes that could change the vegetative make-up of physiographic provinces. For more on the potential changes to vegetation, see section 3.3.1.

3.2.5 Geology and Minerals

3.2.5.1 Background

Under the Naval Petroleum Reserves Production Act, all lands within the NPR-A were, "reserved and withdrawn from all forms of entry and disposition under the public land laws, including the mining and mineral leasing laws, and all other Acts."

For the purpose of this IAP-EIS, "hardrock minerals" is used to describe those potentially valuable mineral occurrences and deposits not considered energy minerals (e.g., oil, coal, geothermal) or common mineral materials (e.g., aggregate, clay, limestone, also known as "salable minerals"). Hardrock minerals, as defined here, refer to locatable minerals (e.g., lead, zinc) and solid leasable minerals (e.g., sulfur, phosphate, potash) generally found in lode deposits within the planning area.

The following sections present an overview of the geology and geologic investigations; describe the known, existing hardrock mineral resources; current restrictions that prevent mining in the NPR-A; and identify areas of high, medium, and low mineral occurrence potential based on the types of mineral resources known to exist in the area. A separate subsection, 3.2.5.3, describes the coal resources of NPR-A, and section 3.2.9 describes the salable minerals.

3.2.5.2 Hardrock Minerals

Geology

This section presents an overview of NPR-A geology.

Rock Units - Lithology and Stratigraphy

Beneath the more recent surficial deposits such as floodplain gravels, glacial debris, and peat, the bedrock geology of the NPR-A records a long, nearly 400 million-year history. Bedrock units in the planning area represent a wide range of sedimentary environments including deep-ocean (e.g., limestone, limey mudstones, and shale) and nearshore to non-marine settings with units deposited much closer to their continental source (e.g., sandstone, conglomerates, and organic-rich rocks like coal). The oldest rocks exposed in the NPR-A occur in the Brooks Range, and as a general rule, the sedimentary units become progressively younger northward towards the Arctic coast. Figure 3-5 presents a generalized stratigraphic section of NPR-A geology. In addition to sedimentary units presented in the stratigraphic section, limited exposures of volcanic rocks (basalts and andesite) and intrusive rocks (gabbro, diabase, and granite) of various ages exist in the NPR-A, although generally dating to the Triassic and Jurassic periods.

Geologic Framework - Structural Geology and Tectonics

Structural geology and tectonics both deal with the motions and deformations of the Earth's crust and upper mantle. They differ in that structural geology is mainly the study of deformation in rocks at a scale ranging from the submicroscopic to the regional. Tectonics is predominantly the study of the history of the motions and deformation at a regional to global scale (Twiss and Moores 1992).

Alaska comprises a diverse assemblage of tectonic terranes which were progressively accreted, or added, to the western margin of North America. Essentially, any geologic "terrane" is an assemblage of related rocks shown to occupy a certain geographic area. The NPR-A is underlain by the Arctic Alaska Terrane, which generally includes all of northern Alaska from the Brooks Range to the Arctic coast. Map 3.2.5-1 presents a generalized geologic map for the NPR-A after Mayfield et al. (1988), and Beikman 1980.

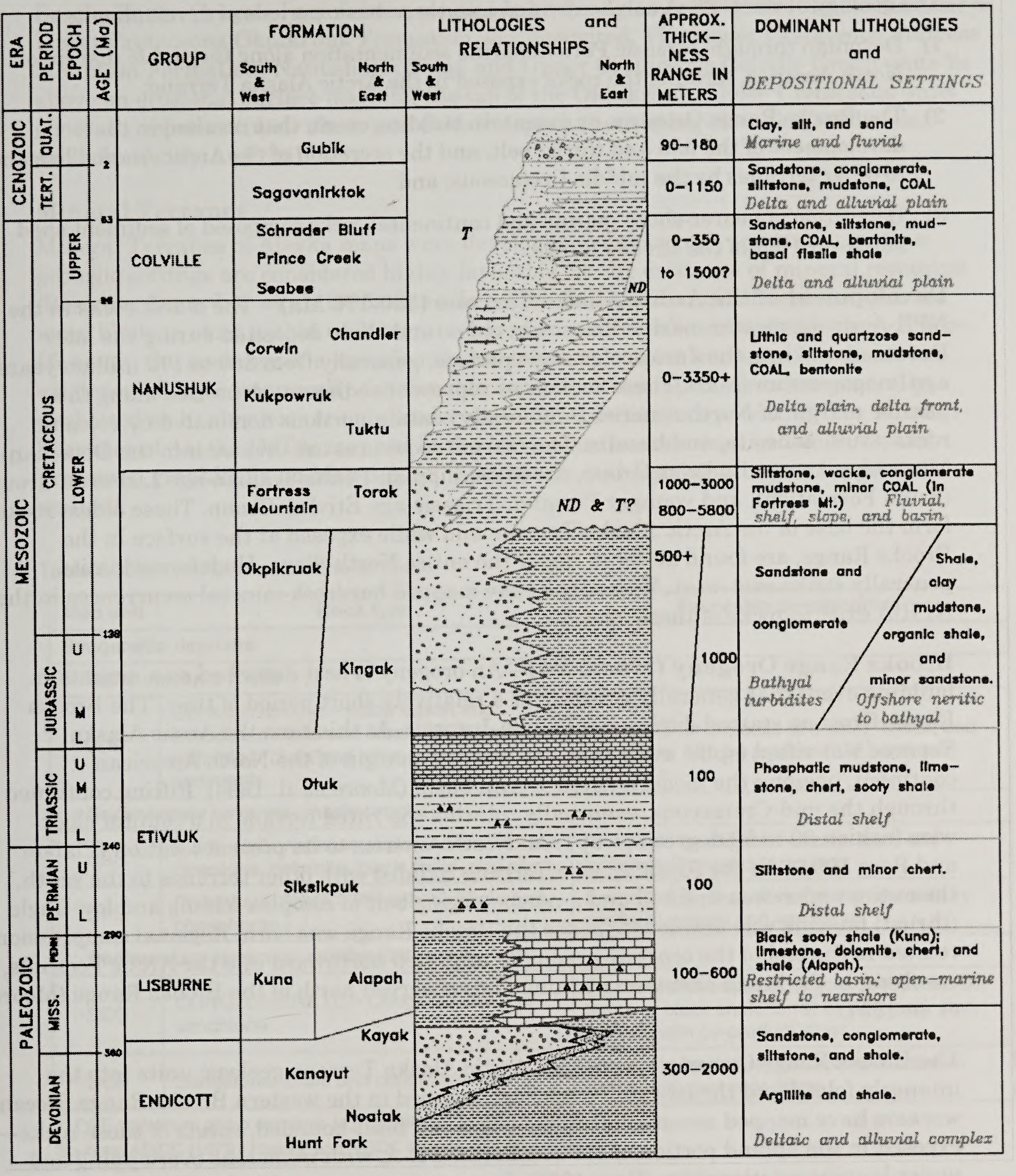
ERA
PERIOD
EPOCH
AGE (Ma)
GROUP
FORMATION
South & West
North & East
LITHOLOGIES and RELATIONSHIPS
South & West
North & East
APPROX. THICK-NESS RANGE IN METERS
DOMINANT LITHOLOGIES and
DEPOSITIONAL SETTINGS
CENOZOIC
QUAT.
Gubik
90–180
Clay, silt, and sand
Marine and fluvial
2
TERT.
Sagavanirktok
0–1150
Sandstone, conglomerate, siltstone, mudstone, COAL
Delta and alluvial plain
63
MESOZOIC
CRETACEOUS
UPPER
COLVILLE
Schrader Bluff
Prince Creek
Seabee
T
ND
0–350
to 1500?
Sandstone, siltstone, mud-stone, COAL, bentonite, basal fissile shale
Delta and alluvial plain
96
LOWER
NANUSHUK
Chandler
Corwin
Kukpowruk
Tuktu
0–3350+
Lithic and quartzose sand-stone, siltstone, mudstone, COAL, bentonite
Delta plain, delta front, and alluvial plain
Fortress Mountain
Torok
ND & T?
1000–3000
800–5800
Siltstone, wacke, conglomerate mudstone, minor COAL (in Fortress Mt.) Fluvial, shelf, slope, and basin
Okpikruak
500+
138
JURASSIC
U
M
L
Kingak
1000
Sandstone and conglomerate
Bathyal turbidites
Shale, clay mudstone, organic shale, and minor sandstone.
Offshore neritic to bathyal
TRIASSIC
U
M
L
Otuk
100
Phosphatic mudstone, lime-stone, chert, sooty shale
Distal shelf
ETIVLUK
240
PERMIAN
U
L
Siksikpuk
100
Siltstone and minor chert.
Distal shelf
290
PALEOZOIC
PENN
MISS.
LISBURNE
Kuna
Alapah
100–600
Black sooty shale (Kuna); limestone, dolomite, chert, and shale (Alapah).
Restricted basin; open-marine shelf to nearshore
Kayak
360
DEVONIAN
ENDICOTT
Kanayut
Noatak
Hunt Fork
300–2000
Sandstone, conglomerate, siltstone, and shale.
Argillite and shale.
Deltaic and alluvial complex

Figure 3-5. Generalized stratigraphy of the NPR-A

Note: T = tectonic and erosional unconformity; ND = mostly non-depositional ([Colville MD Executive Summary] Meyer et al. (1995).

The geology of the NPR-A can be divided into three basic periods of development:

1) Devonian through Jurassic Period marine sedimentation along the stable margin of North America, forming the rocks exposed in the Arctic Alaska Terrane;
2) The Brooks Range Orogeny, or mountain building event, that resulted in the development of the fold and thrust belt; and the accretion of the Arctic Alaska Terrane to other terranes by the middle Cretaceous; and
3) Deposition of nearer-shore marine and continental rocks composed of sediment shed northward out of the Brooks Range.

Development of the Arctic Alaska Terrane (380-170 Ma) – The oldest rocks in the NPR-A are deepwater marine limestone, chert, and shale deposited during the later Devonian and into the Jurassic geologic periods, generally from 380 to 170 million years ago (mega-annum (Ma)). These sequences represent sediments deposited along the passive margin of North America, and locally contain portions dominated by volcanic rocks—tuff, andesite, and basalts. The marine sequences are divided into the Devonian-Mississippian-age Endicott Group, the Mississippian-Pennsylvanian-age Lisburne Group (Kuna Formation), and younger Permian-Triassic-age Etivluk Group. These oldest rocks form the base of the Arctic Alaska Terrane and while exposed at the surface in the Brooks Range, are found at depth under the entire North Slope. Undeformed units generally strike east-west. Virtually all the mapped hardrock mineral occurrences in the NPR-A exist in rocks of these ages.

Brooks Range Orogeny (170-96 Ma) – An orogeny is best described as a mountain building event that generally occurs over a relatively short period of time. The Brooks Range Orogeny started during the Middle Jurassic. At this time the Arctic Alaska Terrane was rifted (split) away from the western margin of the North American continent, opening the modern Arctic Ocean basin (Moore et al. 1994). Rifting continued through the mid-Cretaceous, eventually rotating the rifted terrane in a counter clock-wise fashion 30 to 50 degrees away from North America to its present location (Plafker and Berg 1994). As the Arctic Alaska Terrane collided with other terranes to the south, the entire region was uplifted and a north-verging belt of complex folding and low-angle (thrust) faulting was developed; hence the Brooks Range was born. Regional compression related to the end of the orogeny gradually migrated northward into the Arctic Foothills, resulting in the broad east-west striking folds observed north of the Brooks Range (Moore et al. 1994).

The Brooks Range Orogeny rearranged Arctic Alaska Terrane geologic units into the intensely folded and thrust-faulted package mapped in the western Brooks Range. Recent workers have mapped seven allochthons—distinct, fault-bounded, sheets of these rocks—exposed in the upland portion of the southern NPR-A, with numerous overlapping and under-lapping relationships (Gryc 1988). In some areas complex low-angle thrust faulting has resulted in older rocks being placed on top of younger ones. While regional geologic mapping is fairly complete, detailed mapping of the NPR-A portion of the Brooks Range is still unfinished; many parts of the southern NPR-A are mapped as undivided Jurassic to Mississippian-age due to structural complexity and unconsolidated cover.

Brooks Range Erosion (170 Ma-present) – Once uplift of the southern Arctic Alaska Terrane began, erosion started moving sediments to the Arctic Coast. By the end of the

Brooks Range Orogeny, near shore sandstone and conglomerate of the Middle Jurassic to Lower Cretaceous Okpikruak Formation was deposited. The Lower Cretaceous Fortress Mountain Formation, Nanushuk Group, and Upper Cretaceous Colville Group units lie above an erosional surface marking the top of the Okpikruak. These Cretaceous units generally represent near shore and deltaic deposits consisting of wacke, mudstone, sandstone, clay, and coal.

Mineral Terranes

Mineral Terranes of Alaska maps were developed to depict rock associations whose geologic settings are considered highly favorable for the existence of mineral resources (Resource Data, Inc. et al. 1995). Specific commodities and mineral deposit types are more likely to exist within each terrane based on a terrane's particular geologic nature. However, the presence of a specific mineral terrane does not necessarily indicate the existence of any economically developable deposits. Unmapped areas are generally evaluated as having poor to only moderate mineral occurrence potential. The Mineral Terranes of Alaska (MTA) mapped in the NPR-A are summarized in Table 3-3, and presented graphically on Map 3.2.5-2. Exclusively coal-bearing terranes have been omitted.

Table 3-3. Mineral terranes in the NPR-A

Map unit	Rock type	Favorable commodities
Syngenetic deposits		
Mafic volcanic rocks		
VOP	Ophiolitic terrane – pillow basalt and associated mafic and ultramafic intrusives with minor chert and other pelagic sediments.	Favorable for deposits of copper, nickel, and chromium, with by-product PGE[1] and gold.
Sedimentary terranes- marine rocks		
SBS	Black, carbonaceous shale and limestone – limestone, dolomite, black shale, and chert.	Favorable for deposits of zinc, lead, and barium, with by-product silver.
SPS	Phosphatic Shale – Phosphatic shale and phosphorite.	Favorable for deposits of phosphate with by-product uranium and vanadium.
Sedimentary terranes- continental rocks		
SCG	CONGLOMERATE – Conglomerate and sandstone.	Favorable for deposits of gold or deposits like those or black shale terranes with lead, zinc, barium, with by-product silver.
SCB	Sandstone, shale and conglomerate.	Favorable for deposits of coal and uranium with by-product vanadium.

1. PGE = platinum group elements (e.g., platinum, palladium, iridium)
Sources: AEIDC (1979); Hawley and AEIDC (1982); RDI et al. (1995).

The mapping of the mineral terranes in the NPR-A has been conducted by the United States Geological Survey (USGS), Alaska Division of Geological and Geophysical Surveys, U.S. Bureau of Mines and the BLM, but it has been limited to the uplands in the southern boundary area, and to the Brooks Range fold and thrust belt. These mapping programs were looking specifically for locatable minerals. The northern portions of the NPR-A are known for coal, oil and natural gas, not locatable minerals. The mineral terranes in the southern portion of the NPR-A are underlain by Cretaceous to

Mississippian-age sedimentary units but are most closely linked to the extent of Jurassic-age and older marine units. The relatively rudimentary geologic mapping used as a base for the 1970s statewide MTA data has since been updated in some areas, especially for the NPR-A area during mid-1980s.

Administration

The Petroleum Reserve was initially closed to mineral location and leasing beginning in 1923. A closure was reinforced in 1976 by the Naval Petroleum Reserves Production Act (NPRPA), which prohibited all forms of "entry and disposition under the public land laws, including the mining and mineral leasing laws." Hence, no mining claims or solid mineral leases exist within the NPR-A.

Nongovernmental (commercial) mineral exploration activities (surface sampling and mapping) have been permitted by the BLM in the past under the guidance of FLPMA. Surface occupancy permits cover basic exploration activities such as sampling and mapping. Commercial drilling is strictly off-limits under NPRPA unless directly related to oil and gas exploration/geophysics or performed in evaluation of mineral materials for Alaska Natives. Additional use permits may be applicable.

History and Exploration

The following subsections on exploration and history are paraphrased mainly from Kurtak and others (1995).

Development History

There are no recorded accounts of either lode or placer mining in the NPR-A.

Commercial Exploration History

Private companies, including Native corporations, have carried out exploration projects in the NPR-A. Regional reconnaissance was conducted in the 1950s and 1960s. Following the 1970s discovery of the world-class Red Dog zinc-lead-silver deposit, located about 60 miles southwest of the NPR-A, industry interest in the NPR-A intensified. Several mineral exploration companies performed site-specific evaluations of NPR-A mineral occurrences within the same belt of rocks that hosts the Red Dog deposit.

Mineral Investigations

The first published accounts of exploration in the NPR-A area were made by U.S. Navy personnel when, in 1886, a party crossed from the Noatak River to the headwaters of the Colville and floated downstream to Barrow. The first recorded observations of the geology and mineral occurrences in the area were made by USGS geologists during a series of geologic investigations from 1923 to 1926. A series of geologic investigations by the USGS was undertaken from 1944 to 1953, during which the phosphate occurrences were first investigated and barite noted.

An extensive regional geochemical evaluation was conducted in Alaska as part of the U.S. Department of Energy's National Uranium Resource Evaluation between 1974 and 1981. Data from the evaluation, mainly stream- and lake-sediment samples, include analysis of numerous elements in addition to elemental uranium concentrations. In the NPR-A, nearly 3,000 analyses of mainly lake and stream sediments are available, comprising the most comprehensive geochemical survey of the NPR-A.

After 1975 when management of the area was transferred to the BLM, a joint study by the U.S. Bureau of Mines and the USGS undertook to document hardrock mineral resources in the Petroleum Reserve. This study led to the discovery of several zinc and lead occurrences and to the conclusion that more undiscovered occurrences may exist in the NPR-A area. Other projects during the late 1970s through the 1990s included drilling a number of petroleum wells in the upper Colville drainage, compilation of a bedrock geologic map of the southern half of NPR-A, and considerable geochemical sampling by the USGS. The USGS conducted Alaska Mineral Resources Appraisal Program evaluations of the Killik River and Howard Pass quadrangles beginning in the 1990s during which detailed geochemical sampling was conducted and the barite occurrences were examined. In the NPR-A, only the Howard Pass and Misheguk Mountain quadrangles contain significant numbers of USGS samples, including over 3,500 stream sediment, heavy mineral concentrate, and soil sample analyses.

U.S. Bureau of Mines, Colville Mining District Evaluation – The U.S. Bureau of Mines started a five-year evaluation of mineral resources in the Colville Mining District which ended in 1995 (Kurtak et al. 1995, Meyer et al. 1995). The district is located in Northern Alaska, which covers the Colville River drainage and, in the NPR-A, portions of the Howard Pass and Misheguk Mountain quadrangles. Over 20 mineral occurrences were evaluated on a site-specific basis and regional follow-up and sampling generated numerous geochemical anomalies suggesting additional potential. They are shown in Figure 3-6 and Figure 3-7.

BLM Mineral Assessment

The BLM, Alaska State Office Solid Minerals Branch, conducted mineral assessments on public lands. Prior to the closure of the Branch there were updates of the U.S. Bureau of Mines Colville Mining District evaluation, focused on mineral resources in the NPR-A. One of these projects include an airborne geophysical survey (Burns et al. 2006), a gravity survey focusing on the barite deposits of the Howard Pass Quadrangle (Schmidt et al. 2007), and an unpublished geochemical evaluation of the Howard Pass and Misheguk Mountain quadrangles.

Hardrock Mineral Occurrences

Cox and Singer (1987) define "mineral occurrence" as a concentration of a mineral considered to have some value or scientific interest, and "mineral deposit" as an occurrence of sufficient size and grade that it could have economic development potential. With this in mind, the following subsections summarize the existing mineral occurrences and deposits within the NPR-A. Table 3-4 provides a tabulated list of mineral occurrences. The mapped occurrences and deposits are presented on Map 3.2.5-2.

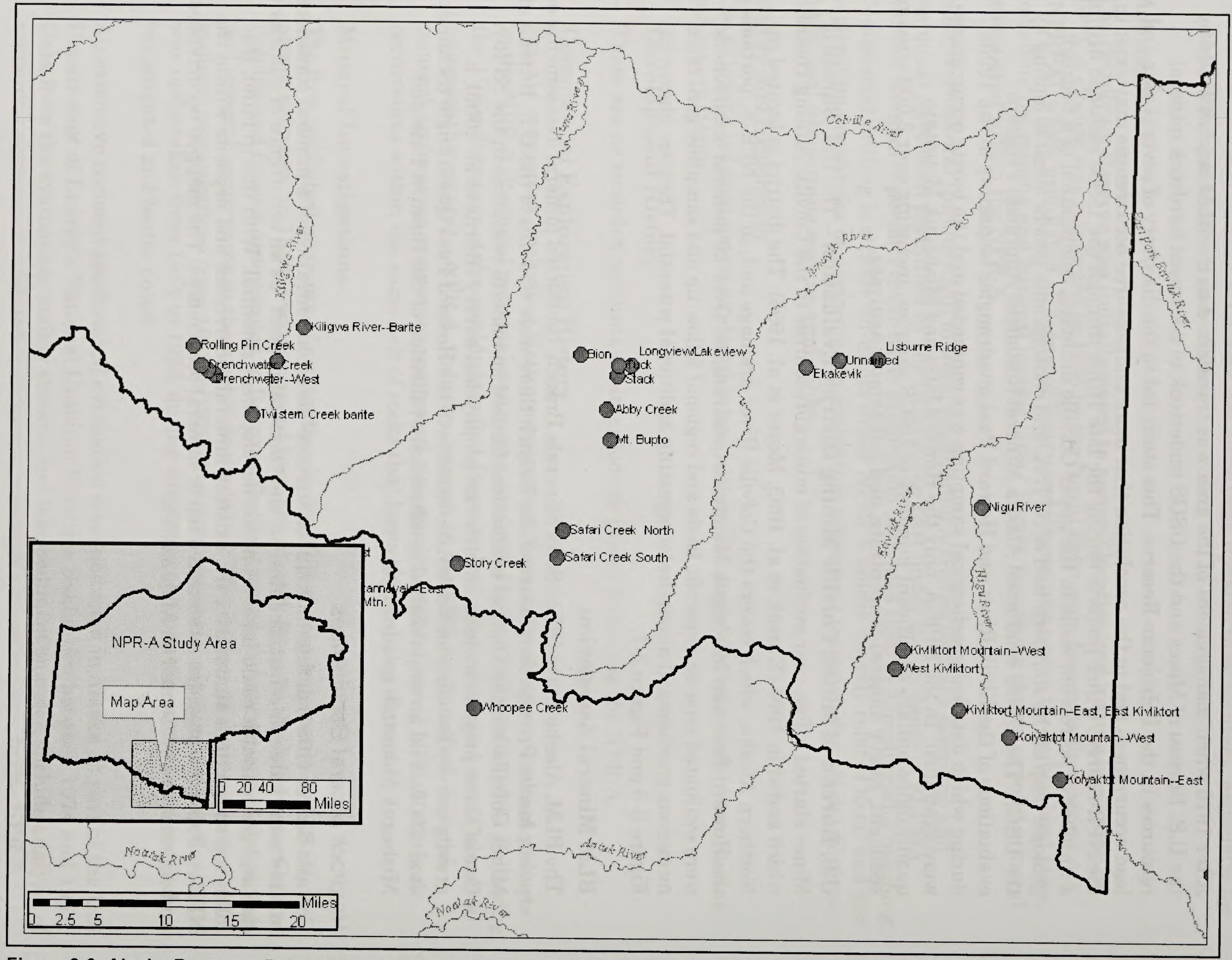
Colville River
Kuna River
Kiligwa River
Ipnavik River
East Fork Etivluk River
Etivluk River
Nigu River
Aniuk River
Noatak River
Noatak River
Kiligwa River--Barite
Rolling Pin Creek
Drenchwater Creek
Drenchwater--West
Twistem Creek barite
Bion
Longview/Lakeview
Tuck
Stack
Abby Creek
Mt. Bupto
Ekakevik
Unnamed
Lisburne Ridge
Nigu River
Safari Creek North
Safari Creek South
Story Creek
arnoval--East
Mtn.
Whoopee Creek
Kivliktort Mountain--West
West Kivliktort
Kivliktort Mountain--East, East Kivliktort
Koiyaktot Mountain--West
Koiyaktot Mountain--East
NPR-A Study Area
Map Area
0 20 40 80
Miles
Miles
0 2.5 5 10 15 20

Figure 3-6. Alaska Resource Data File locations in the southern portion of the NPR-A, Howard Pass Quadrangle

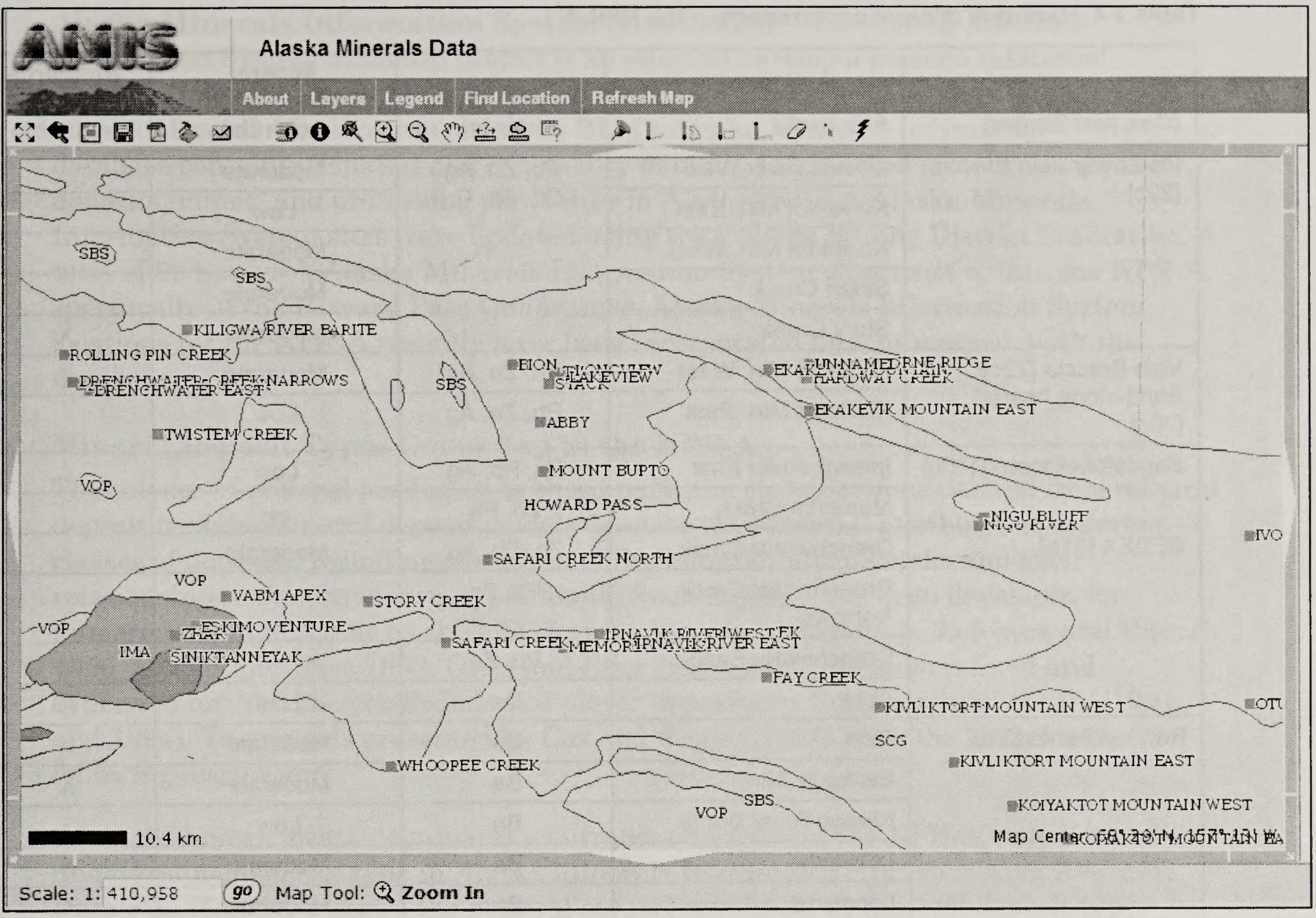
AMIS
Alaska Minerals Data
About
Layers
Legend
Find Location
Refresh Map
SBS
SBS
KILIGWA RIVER BARITE
ROLLING PIN CREEK
DRENCHWATER CREEK NARROWS
DRENCHWATER EAST
SBS
BION
LAKEVIEW
STACK
UNNAMED RIDGE
EKAKEVIK MOUNTAIN EAST
TWISTEM CREEK
ABBY
VOP
MOUNT BUPTO
HOWARD PASS
NIGU BLUFF
NIGU RIVER
IVO
SAFARI CREEK NORTH
VOP
VABM APEX
STORY CREEK
VOP
ESKIMO VENTURE
IMA
SINIKTANNEYAK
SAFARI CREEK
IPNAVIK RIVER EAST
FAY CREEK
KIVLIKTORT MOUNTAIN WEST
SCG
KIVLIKTORT MOUNTAIN EAST
WHOOPEE CREEK
SBS
VOP
KOIYAKTOT MOUNTAIN WEST
10.4 km
Map Center
Scale: 1: 410,958
go
Map Tool: Zoom In

Figure 3-7. Screen capture map from the BLM's Alaska Minerals Information System site showing mineral terranes and Alaska Minerals Information System locations in the Howard Pass Quadrangle

Mineral Occurrences and Deposits

This subsection presents the two primary sources for the current inventory of mineral resources in the NPR-A. A minority of the sites listed in this subsection are only loosely considered "occurrences" as no minerals of economic interest have been identified, but are included on the basis of anomalous geochemistry. These are shown in Table 3-4 shown with a low mineral development potential.

Alaska Resource Data Files (Dover 1997a, Dover 1997b) – The USGS published Alaska Resource Data Files for both the Misheguk Mountain and Howard Pass quadrangles in 1997—the only NPR-A areas covered by the Alaska Resource Data Files. An Alaska Resource Data File is an online public database that records locations and descriptions for metallic mineral mines, prospects, and occurrences and certain other high-value industrial mineral commodities. A minority of included sites are only loosely considered "occurrences" as no economic minerals of interest have been identified, but are included on the basis of anomalous geochemistry. Figure 3-6 and Figure 3-7 show the data file mineral occurrences locations for the southern portion of the NPR-A.

Table 3-4. Hardrock mineral occurrences in the NPR-A

Deposit model (Cox and Singer)	Site name	Commodities (minor)	Mineral development potential	Resource estimate available
Pb-Zn-Ag Vein Breccia [22c]	Ipnavik River West	Pb, Zn, Ag (Cd, Sb, Cu)	Moderate	
	Koiyaktot Mtn. East		Low	
	Koiyaktot Mtn. West		Moderate	
	Safari Creek		Moderate	
	Story Creek		Moderate	X
Vein Breccia [22c]/ Sand-stone hosted [30c]	Kivliktort Mtn. West	Pb, Zn, Ag	Moderate	
	Kivliktort Mtn. East	Pb, Zn, Ag	Low	
Sandstone-hosted [30c]	Ipnavik River East	Zn, Pb, Ag	Low	
	Memorial Creek	Zn, Pb	--	
SEDEX [31a]	Drenchwater Creek	Zn, Pb, Ag	Moderate	
	Drenchwater Creek Narrows	Pb, Zn	--	
	Drenchwater East	Pb, Zn	--	
	Abby	Ba	Low	X
Bedded Barite [31b]	Bion	Ba	Moderate	X
	Ekakevik Mtn.	Ba	Moderate	X
	Kiligwa River Barite	Ba	Low	
	Lakeview	Ba	Moderate	X
	Longview	Ba	Moderate	X
	Stack	Ba, P2O5	Moderate	X
	Tuck	Ba	Low	X
	Twistem Creek	Ba	--	
	Lisburne Ridge	P2O5, Zn, U, V	Low	
Upwelling type phosphate [34c]	Mount Bupto	P2O5, F, U	Low	
	Ekakevik Mtn. East	P2O5	--	
Undetermined	Fay Creek	P2O5	--	
	Hardway Creek	P2O5	--	
	Nigu Bluff	Zn, Cr	--	
	Nigu River	P2O5, V	--	
	Rolling Pin Creek	Ba	--	
	Safari Creek North	Ba	--	
	Unnamed	Cu	--	
	Tukuto Creek	Zn, Pb	--	

Ag=Silver; Ba=Barium; Cd=Cadmium; Cu=Copper; Cr=Chromium; F=Fluorite; P=Phosphorous; Pb=Lead; P2O5=Phosphate; Sb=Antimony; Tl=Thallium; U=Uranium; V=Vanadium; Zn=Zinc

Sources: Cox and Singer (1986); Kurtak et al. (1995)

Alaska Minerals Information System (BLM 2006) – The Alaska Minerals Information System database project is an effort to develop a modern relational database to enable mineral occurrence information storage and retrieval for the BLM Alaska Mineral Assessments program. BLM's Alaska Minerals Information System is a database containing spatial and commodity data for documented mineral occurrences, deposits, mines, and processing plant sites in Alaska. NPR-A Alaska Minerals Information System sites were updated using the Colville Mining District evaluation. A total of 32 hardrock Alaska Minerals Information System sites exist within the NPR-A, specifically in the Howard Pass Quadrangle. Alaska Minerals Information System locations for the NPR-A recently have been incorporated into, or merged, with the database.

Mineral Deposit Types Occurring in the NPR-A

The science of mineral prediction is based partly on classifications derived from mineral deposit models. Mineral deposit models describe the essential attributes of different classes of deposits, including the origin of the mineral-hosting rocks and their relationship to the commodity types found. Such models have been developed for numerous mineral types by the USGS and other researchers (e.g., Lefebure and Church 1996, Mosier and Bliss 1992, Orris and Bliss 1991), and have been refined and expanded for Alaska-specific lode and placer deposits by Nokleberg and others (1987 and 1994). The models presented by Cox and Singer (1986) form the basis for the following discussion.

Of the 32 known locatable mineral occurrences/deposits in the NPR-A, only 8 are of an undetermined deposit type in Alaska Minerals Information System/Alaska Resource Data File. Table 3-4 shows the mineral occurrences listed by mineral deposit type, including those eight undetermined types. The undetermined type is used to describe generally poorly understood occurrences and geochemical anomalies. The remainder of this subsection describes those deposit model occurrences mapped in the NPR-A. Deposit model types form the basis of the mapped potential areas described under "Hardrock Potential Ratings" on page 167 of this chapter.

Pb-Zn-Ag Vein Breccias [(modified) Cox and Singer Model: 22c] – The Pb-Zn-Ag vein breccias in the NPR-A can be described as clastic metasediment-hosted veins, after Lefebure and Church (1996). As a model, these deposits consist of massive and disseminated sulfides in veins, emplaced along faults and fractures in sedimentary basins dominated by clastic rocks.

In the NPR-A, the vein breccia deposits are concentrated in the upper portion of the Devonian Endicott Formation near a major thrust-fault contact with the younger Mississippian Lisburne Formation. The occurrences are concentrated within a 90-mile long belt that trends southeast from the southern Howard Pass Quadrangle and out of the NPR-A. The largest vein breccia deposit in the NPR-A is at Story Creek where grades average 18 percent zinc-lead with almost 5 ounces per ton silver. The vein breccia type deposits are probably best developed by underground mining techniques.

Sandstone Pb-Zn [30c] – Disseminated sphalerite and galena occur as fine-grained disseminations and fracture fillings in silica altered, recrystallized sandstone. Generally these deposits are open-pit development targets. In the southern portions of the NPR-A, sandstone [Pb-Zn] occurrences may also have a mineralized component alternatively described by the Vein Breccia Pb-Zn-Ag [22c] model.

Sandstone Pb-Zn deposits are generally much lower grade than other base-metal types in the NPR-A, but potential exists for large tonnages due to extensive host rocks. In the NPR-A, these deposits are concentrated near thrust-fault contacts with Lower Mississippian Kayak Shale along a 35-mile long belt in the southern Howard Pass Quadrangle.

Sedimentary Exhalative (SEDEX) [31a] – SEDEX deposits consist of generally tabular to lensoidal massive sulfide bodies hosted by carbonaceous/organic-rich black shales. SEDEX deposits are formed in marine basins from the metal and sulfur-rich fluids generated by submarine volcanism. Fluids are released at or near the seafloor where the metals are deposited by density currents near to where they are vented. In the case of the world class Red Dog deposit, ore is capped by massive barite, suggesting additional SEDEX potential in proximity to bedded barite [31b] occurrences. Deposits are developed by both open-pit and underground methods.

In the NPR-A, SEDEX models occur in Upper Mississippian to Permian Kuna and Siksikpuk Formations. Rock types include shale and siliceous mudstones with associated andesitic volcanics. The Drenchwater mineral occurrence is thought to be a SEDEX type deposit.

Bedded Barite [31b] - Structurally controlled, tabular barite bodies lie along allochthon boundaries or are associated with high-angle faults. The deposits may precipitate as chemical sediments exhaled form from hydrothermal fluids or through oxygenation of waters in reduced basins. These deposits have some affinity to the SEDEX model (31a) occurring, in the case of the world-class Red Dog deposit, as a barite cap above economic Pb-Zn mineralization. Deposits are typically developed by open-pit methods, but underground techniques can be applied.

Upwelling Phosphate [34c] – In warm latitudes, those marine sedimentary basins with good connection to the open sea and cold, upwelling waters are areas highly productive of plankton. Phosphate deposits evolve from organic-rich sediments in this type of environment, globally between the 40th parallels. Individual phosphate beds, composed of phosphate pellets/nodules and phosphatized shell and bone material, may be multiple feet thick or more and extend over thousands of acres. In the NPR-A, oolitic, shaley limestone and mudstone of the Upper Mississippian Lisburne Group contain phosphate beds. Deposits are developed by open-pit or other surface mining methods.

Strategic and Critical Minerals

Certain mineral commodities have been termed "strategic" or "critical" by the U.S. Government. Strategic minerals are those that are essential to national defense, for which we are mostly dependent on foreign sources during war, and for which strict measures controlling conservation and distribution are necessary. Critical minerals are also essential to national defense, but their procurement during war is less serious because they are either produced domestically or can be obtained through more reliable foreign sources (Thrush 1968).

The USGS compiled a report documenting the strategic and critical mineral resources of the NPR-A (Ellersieck and Tailleur 1986). Although the NPR-A has not been explored exclusively for these occurrences, the authors suggest that the area has a "very low potential" for the existence of most strategic or critical minerals. Only zinc, lead, silver, cadmium, and antimony are known to exist in potentially recoverable quantities in the NPR-A.

Hardrock Potential Ratings

Occurrence potential ratings for hardrock minerals in the NPR-A have been developed based on a number of evaluations and data sets, including mineral terranes, geologic mapping, the Colville Mining District evaluation, and the probabilistic assessment made by Werdon and others (1996). These separate data sets are then combined to provide a qualitative “weight of evidence” supporting the determination of hardrock mineral occurrence potential. This subsection summarizes the potential ratings and describes each mineral potential area mapped in the NPR-A. While the unmapped portions in the NPR-A could still be considered to have at least some potential for hardrock mineral occurrence, as all areas do, there is no indication of the occurrence of specific mineral occurrences/deposits. Map 3.2.5-2 graphically presents the mapped hardrock mineral potential areas.

Low Mineral Potential Area

The belt of low mineral potential drawn across the southern extreme of the NPR-A encompasses the majority of anomalous regional geochemical survey results, specifically elevated silver, lead, zinc, and barium concentrations. This low mineral potential area is nearly coincident with the non-coal mineral terranes mapped in the NPR-A and additionally circumscribes all the known hardrock mineral occurrences in the NPR-A. Generally, the entire belt of mapped mineral potential is underlain by the Brooks fold and thrust belt, and therefore, may contain unmapped portions of the upper Mesozoic rocks considered the most prospective for additional mineral occurrences. This low mineral potential area has a lower density of anomalous samples, with fewer recognized and less significant occurrences, than the medium mineral potential areas.

Mineral sites within this area include the poorly understood Nigu River and Nigu Bluff sites. Mount Bupto, a fluorite and phosphate bearing shale occurrence, is located in the central portion of the Howard Pass Quadrangle. The Colville Mining District evaluation indicated that only low potential for development of a low-grade, large tonnage phosphate deposit at Mount Bupto.

Medium Mineral Potential Areas

Spike Creek Medium Mineral Potential Area – The Spike Creek Area, in the far southwestern corner in the southern portion of the NPR-A, is based on the recent USGS examination of regional geochemical survey data. Workers found that the Spike Creek and areas immediately east significantly anomalous in Zn, Pb, Ag, U. This suite of elevated metal concentrations is similar to that observed in the Drenchwater and Twistem Creek areas, both of which are interpreted as SEDEX-type deposits by the USGS. Most importantly however, is the similarity between this area’s geochemistry and that found regionally at the producing Red Dog deposit, located 60 miles to the southwest of this medium mineral potential.

No mineral sites exist within this area, which is considered to have potential for base-metal, specifically SEDEX, deposits.

Drenchwater Medium Mineral Potential Area – The Drenchwater medium mineral potential area is an extension of high mineral potential area described below in the next section. The medium mineral potential area has moderate potential for the existence of Bedded Barite and SEDEX Pb-Zn-Ag deposits. The area includes the Werdon et al. (1996) Moderate Favorability areas for SEDEX and Barite deposits. Additionally, an expanded northwestern portion is based on a significant increase in the density of anomalous barite analyses from the regional geochemistry data set.

Identified deposits include the Rolling Pin Creek barite occurrence and the Kiligwa River Bedded Barite deposit. Neither has an identified resource or development potential.

Story Creek Medium Mineral Potential Area – This area covers an over 250,000-acre portion of the southern NPR-A. The bulk of this area was delineated by the Moderate Favorability ranking for Sandstone Hosted Pb-Zn, Pb-Zn-Ag Breccia Vein. Moderate potential exists for these deposit types as expanded from the core high mineral potential area. Geology in the medium mineral potential area is typified by Endicott Group rocks, including the Kanayut Conglomerate, Noatak Sandstone, and Kayak Shale.

Only the poorly understood prospects at Safari Creek North and Tukuto Creek fall within the area. The Tukuto lead and zinc occurrence was evaluated by the Colville Mining District as having only low development potential. In the area surrounding Safari Creek North, the USGS regional geochemical evaluation recognized a Zn-Pb-Ag geochemical signature suggesting additional potential for SEDEX-type deposits. A Moderate Favorability rank from Werdon et al. 1996) exists in the moderate mineral potential area to the west of the Safari Creek deposits.

Cutaway Basin Medium Mineral Potential Area – The Cutaway Basin area is prospective for Bedded Barite deposits based on favorable geology and a significant density of samples with highly anomalous barium concentration. The Colville Mining District evaluation suggests that there is additional potential for Bedded Barite along major allochthon boundaries in the Cutaway Basin. No documented occurrences exist with the medium potential area. The area's geology is dominated by siliceous shale and chert.

Ekakevik Mountain Medium Mineral Potential Area – This medium mineral potential area is an expanded area encompassing numerous barium anomalies demonstrated by the regional geochemical data set. The area lies along a major thrust fault, approximating the northern extent of the most intense tectonic/structural displacement associated with the Brook Range Orogeny. Together these factors suggest a moderate potential for additional discovery of Bedded Barite-type deposits.

Two poorly described sites, an "unnamed" copper occurrence, and phosphate at Ekakevik Mountain East, fall within this medium potential area.

Lisburne Ridge Medium Mineral Potential Area – The Lisburne medium mineral potential area exists as thin sliver of Lisburne Group phosphatic chert, shale and dolomite along the west-east elongate Lisburne Ridge. Phosphate-rich rubble fragments up to 3 inches thick are present along an over 3-mile section of Lisburne Ridge. Results of the Colville Mining District evaluation indicate that although individual phosphate beds were high-grade, with greater than 24 percent phosphate, there was only low potential for significant tonnage. Potential for thicker beds, however, does exist in the medium mineral potential area.

High Mineral Potential Areas

Drenchwater High Mineral Potential Area – The Drenchwater Creek high mineral potential area is highly prospective for the occurrence of SEDEX mineralization, with associated Bedded Barite. Samples highly anomalous in barium, lead, zinc and silver are clustered in this area, which also includes areas judged by Werdon et al. (1996) as possessing a high mineral endowment, based on zinc commodity. The recent USGS geochemical survey compilation indicates that significant potential for stratiform Pb-Zn deposits exists not only in the vicinity of the identified mineralization at Drenchwater, but also at Twistem Creek and further to the east of the Kiligwa River. The area is typified by anomalous U, P, and Tl concentrations similar to those near Drenchwater, in addition to the standard Zn-Pb-Ba suite. Five mineral occurrences are encompassed by the high mineral potential area.

Known SEDEX mineralization at Drenchwater Creek (and associated sites Drenchwater East and Drenchwater Creek Narrows) occurs along a surface expression of over 10,000 feet of strike, with contained metal values up to an average of 6.8 percent zinc, 6.7 percent lead, and 43.6 grams/ton silver. The down-dip extension of mineralization is unknown. The Colville Mining District evaluation determined moderate potential for a stratiform zinc-lead deposit, due to extensive exposures and grades at the site.

Twistem Creek is described as a bedded barite type deposit, but recent USGS evaluations have identified additional potential for SEDEX-style mineralization in the vicinity of the creek.

Story Creek High Mineral Potential Area – The Story Creek high mineral potential area encompasses a 50-mile long belt in the southeast portion of the NPR-A. The area is highly prospective for both Vein Breccia Zn-Pb-Ag and Sandstone-hosted Pb-Zn deposits. The Werdon et al. (1996) probabilistic model indicated a high mineral endowment of Zn (Pb-Ag) resources for this area. A total of 9 deposit model occurrences and one unknown model of occurrence exist in the mapped area.

Story Creek is the only deposit within the belt of high mineral potential that possesses resource information. Mineralization occurs in an en-echelon series of sulfide-bearing veins and breccia zones. These occurrences are mapped with a combined strike length of more than 7,000 feet and thicknesses range from approximately 15 feet to 200 feet. The Colville Mining District evaluation inferred a resource base of over 3,000,000 tons of 14.2 percent zinc, 3.9 percent lead, and 159 grams/ton silver.

Cutaway Basin High Mineral Potential Area – The Cutaway Basin high mineral potential area is typified by anomalous barium-in-sediment values, but lacks appreciable base metal enrichment. The area is highly prospective for Bedded Barite Deposits and contains five Bedded Barite deposit model occurrences. The standard for barite use in oil-well drilling fluid is that the specific gravity must be a minimum of 4.2. The Cutaway Basin area barite appears to meet or exceed these requirements for all but the Lakeview Occurrence (Kelley et al. 1993). Table 3-5 shows this information.

Table 3-5. Cutaway Basin resources

Deposit	Tonnage	Grade BaSO4	Specific Gravity
Abby Creek	406,000	95.1%	4.25
Bion	10,051,000	95.7%	4.25
Lakeview	3,774,000	unknown	4.13
Longview	29,494,000	unknown	4.13 – 4.2
Stack	2,851,000	95.8%	4.21
Tuck	155,000	95.9%	4.31

Ekakevik Mountain High Mineral Potential Area – The Ekakevik Mountain high mineral potential area is typified by Mississippian Lisburne Group chert, shale, and minor limestone. The probabilistic model used by Werdon et al. (1996) indicated that this area contained a high mineral endowment for barium. Regional geochemistry is likewise anomalous in Ba. The area lies along a major thrust fault, approximating the northern extent of the most intense tectonic/structural displacement associated with the Brook Range Orogeny. The area is prospective for Bedded Barite Deposits.

The area includes the Ekakevik Mountain deposit with an inferred reserve of 2.276 million tons at 97.1 percent barite and a specific gravity of 3.9. The Ekakevik Mountain East site is a poorly understood phosphate occurrence (Kelly et al. 1993).

3.2.5.3 Coal Resources

Alaska's North Slope is a large coal-rich basin situated in the western portion of the Northern Alaska Coal Province. The first written record of the interest in Alaskan coal is that of Captain Nathaniel Portlock who discovered and used coal on the Kenai Peninsula in 1786, although Alaska Native peoples and Russian fur traders had been using coal and oil shale long before that for heat and fuel (Sanders 1980). In the 19th century, whaling ships and U.S. Revenue cutters took on coal from beds near Cape Sabine, south of Point Lay on the Chukchi Sea coast (Sanders 1980).

The main coal bearing rock formation in the NPR-A is the Lower Cretaceous-age Nanushuk Group. The Nanushuk Group underlies a large portion of the NPR-A, generally west and north of the Colville River, encompassing approximately 32,000 square miles of coal-bearing rocks. Flores and others (2004) cite identified coal resources of 120 billion tons and hypothetical coal resources of about four trillion tons in Alaska, or approximately one-third of the United States estimated coal resources. Most of this coal is from the Nanushuk Group that underlies the NPR-A. Figure 3-8 (next page) presents thickness and extent of Nanushuk Group coal beds in the NPR-A.

The entire Nanushuk depositional sequence is about 8,000 feet thick near the Tunalik well on the west and thins to about 3,000 feet thick near the Ikpikpuk River (Bird 1988a). Additional geophysical logging suggests that the coal bearing strata are widespread across the western NPR-A (Callahan and Martin 1981). The thickest coal is in the middle and western portion of the NPR-A where the Nanushuk Group consists of predominantly non-marine sediments. According to Tyler, Scott, and Clough (1988), the Tunalik, Kaolak, and Meade wells define an elliptical-shaped coal depositional center southwest of Atqasuk, which is shown in Figure 3-8).

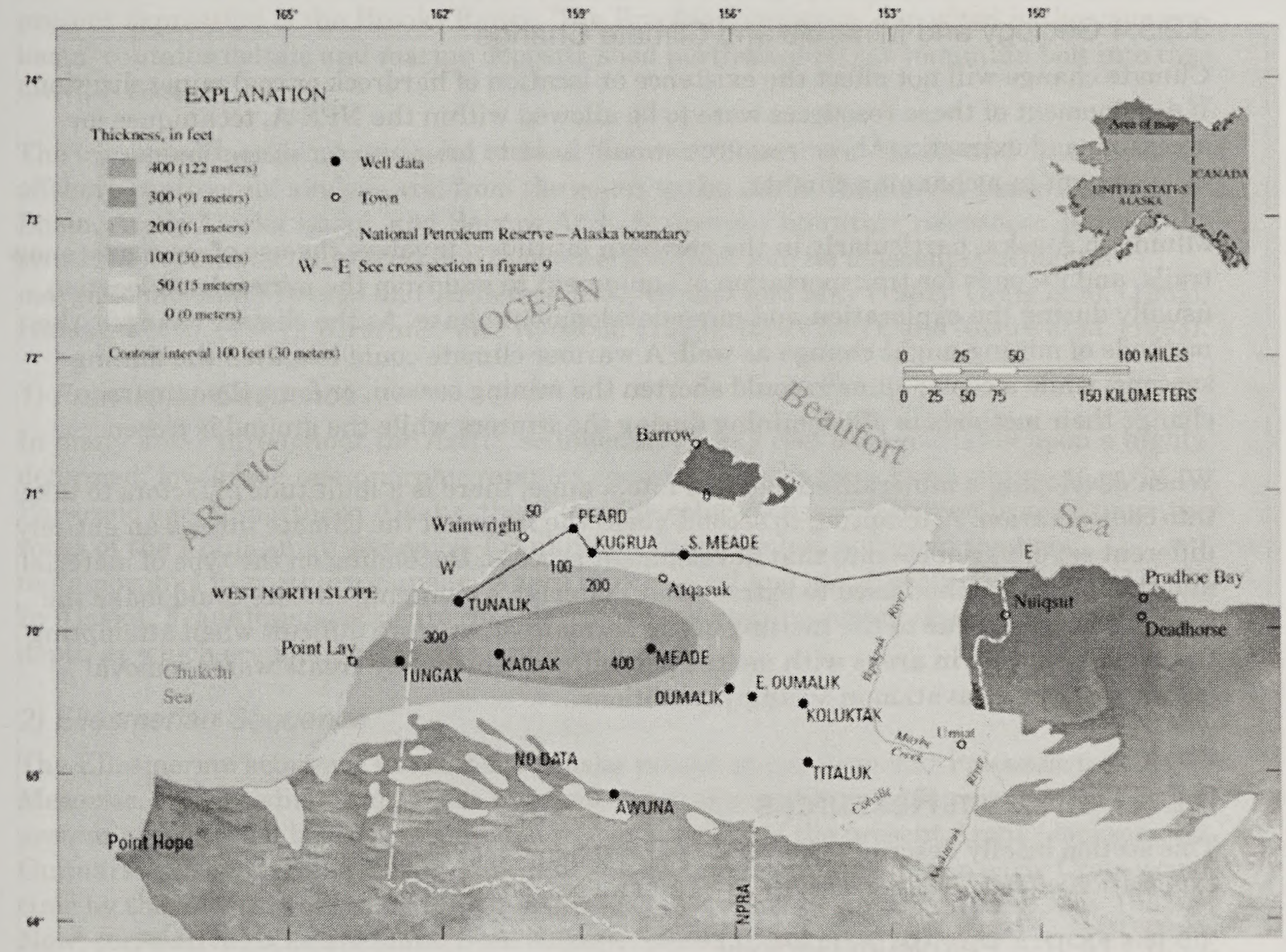
165°
162°
159°
156°
153°
150°
74°
73
72°
71°
70°
69
68°
EXPLANATION
Thickness, in feet
400 (122 meters)
300 (91 meters)
200 (61 meters)
100 (30 meters)
50 (15 meters)
0 (0 meters)
● Well data
○ Town
National Petroleum Reserve—Alaska boundary
W – E See cross section in figure 9
Contour interval 100 feet (30 meters)
Area of map
CANADA
UNITED STATES ALASKA
0 25 50 100 MILES
0 25 50 75 150 KILOMETERS
ARCTIC
OCEAN
Beaufort
Sea
Barrow
Wainwright
PEARD
KUGRUA
S. MEADE
Atqasuk
W
E
WEST NORTH SLOPE
TUNALIK
Point Lay
TUNGAK
KAOLAK
MEADE
Chukchi Sea
Nuiqsut
Prudhoe Bay
Deadhorse
E. OUMALIK
OUMALIK
KOLUKTAK
Umiat
NO DATA
TITALUK
AWUNA
Point Hope
NPRA
50
100
200
300
400
0

Figure 3-8. Net coal thickness map of the Nanushuk Group in the western part of the Northern Alaska coal province (Source: Flores et al. (2004))

Well log analyses of oil and gas exploration drilling suggest there are over 150 coal beds ranging from a couple of inches to over 20 feet thick in the Nanushuk Group, while the total aggregate thickness of the many coal seams exceeds 300 feet (Flores et al. 2004). Seams thinner than 42 inches can be mined, but only as part of multi-seam mining operations which will take the waste material between the seams. The coal beds near the Kukpowruk River, just west of the NPR-A, have been analyzed for mining using both open pit and underground methods. The overburden thicknesses range from less than 120 feet to a maximum of 2,000 feet (Knutson 1980) Analyses of the coal in this region show that it is low sulfur, low ash, and sub-bituminous; however, the rank increases to bituminous further south, coincident with the folding and faulting of the Brooks Range. Consequently, most of the NPR-A north of the Colville River is expected to have comparatively less coal, but of higher rank than the coal found in the western portion of NPR-A.

Although the coal resources in the NPR-A are extensive, the region's remote nature brings large logistical and environmental problems in developing them. However, because of the renewed interest in proposed natural gas pipelines, coal resources in the NPR-A may be targeted for the purposes of coalbed methane development.

3.2.5.4 Geology and Minerals and Climate Change

Climate change will not affect the existence or location of hardrock or coal mineralization. If development of these resources were to be allowed within the NPR-A, techniques for accessing and extracting those resources would have to take into consideration mine development in a changing climate.

Mining in Alaska, particularly in the northern latitudes, involves the use of ice roads, snow trails, and ice pads for transportation of equipment to and from the mineralized location, usually during the exploration and mine development phase. As the climate changes, the methods of mining might change as well. A warmer climate could lengthen the mining seasons; while a cooler climate could shorten the mining season, or force the miners to change their methods to allow mining during the winters while the ground is frozen.

When developing a mineralized location into a mine, there is a multitude of factors to take into consideration. Attempting to second-guess the future of the climate throws an entirely different set of variables into that development process. Depending on the type of material and the mining method used to extract that material, a changing climate could make the excavation easier, due to the melting of the permafrost, or more difficult when attempting to develop deposits in areas with melted permafrost, which may create water removal issues, or need excavation in swampy conditions.

3.2.6 Petroleum Resources

This section briefly describes the NPR-A's petroleum geology, historical and recent exploration efforts, leasing activity, and oil and gas potential.

3.2.6.1 NPR-A Petroleum Geology

Sedimentary rocks representing approximately 360 million years of geologic time underlie northern Alaska and the adjacent continental shelf. Three thick stratigraphic sequences were deposited in overlapping geologic basins now lying beneath Alaska's North Slope.

The Arctic Alaska Basin (Map 3.2.6-1) flanked a now-vanished continental landmass that was located north of the present-day Beaufort Sea coastline. This landmass was split away from northern Alaska during rifting that created the modern Arctic Ocean. The Ellesmerian sequence was deposited in the Arctic Alaska Basin and consists of sediments shed southward from the former landmass to the north. The Ellesmerian sequence is composed of rock units that grade from proximal facies (near source terrane) in the north to distal facies (deepwater marine) in the south.

The onset of rifting severed the northern landmass from the Arctic Alaska Basin and terminated the deposition of the Ellesmerian sequence. Following the terminology of Hubbard et al. (1987), sedimentary rocks associated with the rifting are called the "Beaufortian" sequence. The Beaufortian sequence therefore marks a transitional period between the Ellesmerian and Brookian cycles of basin filling. The Beaufortian sequence overlies northern parts of the older Arctic Alaska Basin, but achieves maximum thicknesses in small, faulted basins (graben) north of the Barrow Arch and beneath the modern Beaufort continental shelf.

The Colville Basin was formed as a deep trough on the north side of a mountain belt whose present expression is the Brooks Range. The Brookian sequence, deposited in the younger basin, contains deltaic and marine deposits shed northward off the mountain belt into the Colville Basin.

The major sedimentary basins and tectonic features of northern Alaska and contiguous offshore continental shelves are, from the south to the north, the Brooks Range, Colville Basin, Arctic Alaska Basin, and Barrow Arch. Numerous literature references describe the stratigraphy and tectonic evolution of northern Alaska and its adjacent continental margins, including Brosge and Tailleur (1971), Grantz and May (1982), Craig et al. (1985), Hubbard et al. (1987), Kirschner and Rycerski (1988), Bird (1991), and Moore et al. (1994).

1) Franklinian Sequence

In many areas throughout the Arctic, sedimentary rocks rest uncomfortably upon a highly deformed, low-grade metamorphic complex containing rocks from Precambrian to early Paleozoic age. In northern Alaska, these metamorphic rocks were formed from sedimentary rocks of the Franklinian sequence. Franklinian rocks are less deformed (and not metamorphic) in northern Canada, where they host oil and gas deposits (Stuart et al. 1977). In Alaska, Franklinian rocks are considered as economic basement; that is, the lowest depth at which economic resources might be found.

2) Ellesmerian Sequence

The Ellesmerian sequence in northern Alaska ranges in age from mid-Paleozoic to mid-Mesozoic. These sedimentary rocks were once part of a continuous "supercontinent" with a system of connected basins extending across wide areas of the present Arctic (Jackson and Gunnarsson 1990, Embry 1990). This supercontinent was fragmented in early Cretaceous time by the rifting that created the modern Arctic Oceanic Basin (Grantz and May 1982). Now, correlative rocks are found from eastern Siberia (Chukotka) to the eastern Canadian high Arctic. The rocks recording the pre-breakup basin in northern Alaska are grouped under the name “Ellesmerian sequence” because of their similarity to rocks of the same age that are exposed on northern Canada's Ellesmere Island (Lerand 1973). The Ellesmerian sequence in northern Alaska contains several productive reservoirs, including the Kekiktuk Formation (Mississippian, Endicott Group) in the Endicott/Duck Island and Liberty/Tern Island fields, the Lisburne Group (Mississippian-Pennsylvanian), and the Ivishak Formation (Permian-Triassic, Sadlerochit Group) in the Prudhoe Bay and Northstar fields.

3) Beaufortian Sequence

The breakup of the supercontinent and associated Ellesmerian rocks is represented by marine sedimentary rocks ranging from Middle Jurassic to Early Cretaceous (175 to 115 million years ago). These strata are referred to as the "Beaufortian sequence," a name applied by Hubbard et al. (1987) to rift zone deposits along the Beaufort Sea continental margin. The Beaufortian sequence contains rocks correlative to reservoirs in five major commercial fields on the North Slope, including the Kuparuk, Point McIntyre, Alpine, Milne Point, and Niakuk fields. Beaufortian sequence sandstones contain gas reserves at the South Barrow, East Barrow, Sikulik, and Walakpa fields near Point Barrow. Oil and gas accumulations have been discovered (but remain undeveloped) in the Alpine sandstones (Jurassic) at the Lookout, Mooses Tooth, Mitre, and Rendezvous sites in the northeastern NPR-A.

4) Brookian Sequence

With continental breakup from seafloor spreading in the Arctic Oceanic Basin, crustal movements caused collisions along plate margins between fragments of the original continent and outlying, independent continental masses. These collisions caused uplift of new mountain belts and complementary foreland sedimentary basins (Bird and Molenaar 1992). The actively subsiding basins flanking the mountain belts received clastic debris that was eroded from the adjacent mountains. In northern Alaska, the rocks recording this collision are termed the "Brookian sequence" in deference to their association with the Brooks Range. Rocks correlative to the Brookian sequence are found on all circum-Arctic continents, but are highly variable because of their independent source terranes and basin types. Brookian rocks in northern Alaska include nonmarine, deltaic, and deep-marine strata, ranging from Early Cretaceous (about 115 million years ago) to the present. Brookian reservoirs have not contributed significantly to North Slope production, though numerous marginally commercial discoveries are now under production, including the West Sak/Kuparuk, Schader Bluff/Milne Point, Tarn, Meltwater, Qannik and Nanuq fields. The Badami field was a short-lived development of an oil accumulation in turbiditic sandstones east of Prudhoe Bay. Badami production was abandoned in 2007 after 9 years of development effort.

3.2.6.2 Exploration and Leasing

Past Exploration Efforts

The first systematic geological reconnaissance of the Alaska North Slope detailed the existence of active oil seeps at several locations, numerous coal seams, sedimentary stratigraphy and geological structures where oil or gas might be found (USGS Bulletins, Professional Papers and Geologic Notes, 1904 to 1919 and from 1923 to 1926). Prior to the Mineral Leasing Act (1923), the North Slope's most extensive oil seeps at Cape Simpson were mined by the Inupiat and later prospectors filed claims in this area (Joesting and Ebbley 1943).

From 1944 to 1952, the U.S. Navy drilled exploration wells near oil seeps and on surface anticlines, resulting in several oil and gas discoveries. Umiat was the first oil field discovered in northern Alaska (1946). However, it remains undeveloped. The South Barrow gas field was the first significant gas discovery (1949) on the North Slope, and it was developed in 1958 by the Federal government to supply fuel to the village of Barrow.

A second phase of NPR-A exploration started in the 1970s. It began under the auspices of the U.S. Navy, but was later coordinated by the USGS, with the passage of the Naval

Petroleum Reserves Production Act in 1976. This exploration effort resulted in 28 exploration wells (Husky Oil Company) and 14,800 miles of seismic data (Geophysical Services, Inc.). Numerous oil and gas shows were reported, but no commercial fields were discovered. Gas fields near Barrow (Barrow and Walakpa) were developed through government subsidies and currently are produced for local use.

The discovery of the Alpine field in the Colville River Delta helped renew exploration interest in the NPR-A. The Alpine field was discovered by ARCO and partners in the winter of 1994–1995 (Alaska Report 1996). Development and appraisal drilling confirmed its reserve potential of 429 million barrels, and by the end of 2009, the Alpine field had produced a total of 327 million barrels of oil (Alaska Division of Oil and Gas 2009). The field may have economically recoverable reserves as high as 500 million barrels (Gingrich 2001). The Alpine field is the largest field discovered in Alaska since the discovery of the Point Mclntyre field in 1988 and is one of the largest fields discovered in the U.S. in recent decades. Of particular significance is that the Alpine field discovery has revealed a new geologic play in previously unknown sands in the Jurassic section. The new Jurassic play extends westward into the NPR-A and has been a principal target of recent exploration in the northeastern and north-central parts of the NPR-A.

Leasing Activities

Federal lands have not always or regularly been available for industry exploration. Between 1958 and 1966 BLM offered a total of more than 19 million acres east and west of the NPR-A for oil and gas leasing and exploration. Most exploration was conducted under the simultaneous oil and gas application process. The BLM also offered competitive bidding on about 16,000 acres. Federal incentives in development contracts on the simultaneous oil and gas application lands helped to offset the high expenses of drilling and seismic exploration in this remote area. Industry exploration made gas discoveries east of the NPR-A and most of it was subsequently selected by the State. No leases were taken up west of the NPR-A (Banet 1991).

Federal leasing in NPR-A between 1982 and 1985 (sales #821, #822, #831 and #841) offered between about 1.5 and 3.5 million acres tracts across the NPR-A. A fifth sale (#851) was cancelled because of legal challenges, expensive exploration failures, comparatively low oil prices, and waning industry interest in the North Slope during the mid-1980s. Each of these sales offered some tracts from the various geological provinces: the Coastal Plain, the Foothills, and the Brooks Range fold belt. Table 3-6 shows leasing results from these first four NPR-A sales. All leases expired or were relinquished by 1992.

After the signing of the Northeast NPR-A IAP Record of Decision in 1998, the BLM in 1999 offered approximately 3.9 million acres of the planning area's 4.6 million acres; no tracts were offered in an area north and east of Teshekpuk Lake (see Table 3-6). A sale in 2002 offered previously unleased tracts in the Northeast NPR-A planning area. Leasing of tracts west of the Ikpikpuk River began after the signing of the Northwest NPR-A IAP Record of Decision in 2004. Approximately 5.8 million acres were offered for leasing in 2004 and 2006. In 2008 unleased tracts from both the Northeast and Northwest NPR-A planning areas were offered for sale. A sale in 2010 offered about 1.86 million acres of the Northeast NPR-A planning area. Five tracts peripheral to the Greater Mooses Tooth Unit were leased.

In 2011, BLM held a lease sale for selected tracts in the Northeast and Northwest NPR-A planning areas. Industry bid on 17 tracts and all were issued as leases by the BLM.

Table 3-6. Table of NPR-A sales, bids, acreage and revenues

Sale	Date	Tracts offered	Bids	Leases issued	Acres offered	Acres leased	Winning bonus bids
821	1/27/1982	59	52	26	1,500,500	653,456	$ 58,137,620
822	5/26/1982	212	14	12	3,500,000	252,000	9,741,022
831	7/20/1983	84	23	18	2,200,200	419,618	16,666,659
841	7/18/1984	64	0	0	1,600,000	none	0
991	5/5/1999	431	174	133	3,898,612	867,721	104,951,166
2002	6/3/2002	298	69	60	3,010,000	579,269	63,811,496
2004	6/2/2004	504	165	123	5,800,000	1,403,561	53,904,491
2006	9/27/200	478	94	84	5,451,766	939,867	13,860,135
2008	9/24/2008	450	78	78	4,832,073	810,643	17,231,203
2010	8/11/2010	190	5	5	1,860,000	28,444	799,995
2011	12/7/2011	283	20	17	3,060,176	119,987	3,637,477
2012	11/7/2012	398*			4,464,206		
TOTAL		**3,451**	**694**	**556***	**41,177,533**	**6,074,566***	**$342,741,264**

* At the time of writing, the 2012 sale has not been held

The Alpine Oil Field and Recent NPR-A Exploration

Petroleum exploration on State lands discovered the Alpine oil field in 1994. It is adjacent to the northeast NPR-A and it is about 33 miles west of the Kuparuk River field. It was originally developed from two drill pads not connected to the North Slope road system, CD-1, which also included a central processing facility, and CD-2. In 2006, two satellites, CD-3 in the lower Colville River Delta and CD-4 established about half way between the original Alpine development and Nuiqsut, began production. CD-5, originally called Alpine West, is an oil discovery on Kuukpik Corporation lands between the federal portion of NPR-A and CD-4 of the Alpine field. It is scheduled for development as another satellite to Alpine, and is proposed to include a 3-phase pipeline and a bridge across the Nigliq Channel of the Colville River, with construction expected to begin in early 2014 and first production planned for late 2015. Kuukpik Corporation and Arctic Slope Regional Corporation land selections in northeast NPR-A include the oil and condensate discoveries at CD-6 and CD-7 with their respective mineral estate. Under the current Greater Mooses Tooth (GMT) Unitization Plan, the original proposed development at CD-6 will be renamed GMT-1 and CD-7 will be moved and renamed GMT-2 if it is developed. The proximity of these discoveries in northeast NPR-A to Alpine suggests they will be developed as satellites of Alpine.

Industry has drilled and completed 29 wells in federally managed part of the NPR-A since 2000, including the discovery wells at GMT-1 and GMT-2. There are three additional wells on adjacent Native lands. The upper Jurassic play was the exploration objective for 22 of these NPR-A wells. Table 3-7 shows that the six successful drill stem tests confirm the existence of producible oil, condensate, and gas, although none of these discoveries have been brought into commercial production to date. Fluid flow rates were variable and stimulation (fracturing the reservoir with fluids under high pressure) increased flow rates markedly. These tests show that the oil is predominantly high API gravity and condensate associated with gas. The comparatively high gas:oil ratios show that gas appears to be the predominant resource in the upper Jurassic prospects where oil and gas were tested.

Table 3-7. Drill stem test results from industry exploration in the NPR-A

Well	Barrels of oil per day (BOPD)	MMcfd	API gravity	GOR
Spark #1A	220	2.4	48.5	10,909
Spark #1A*	1550	26.5	55	17,097
Rendezvous A	360	6.6	60	18,333
Lookout #2*	3351	7	40	2,089
Carbon	1250	24	59	19,250
Rendezvous #2*	1300	1.42	36.7	1,092
Pioneer*	440	1.5	49.5	3,400
Altamura	no fluid to wellbore			
Aklaqyaaq 1	gas cut mud			

* indicates artificial well stimulation test (to improve formation flow characteristics).
MMcfd=millions of cubic feet per day
API= American Petroleum Institute, in degrees, a measure of fluid density in which high values correspond to low density
GOR=gas to oil ratio (cubic feet of gas per barrel of oil, at standard conditions [60 deg F, 1 atm.]).

3.2.6.3 Petroleum Potential

Decades of exploration and production of world class oil reserves shows that the North Slope has considerable petroleum potential (Map 3.2.6-2). After the Trans-Alaska Pipeline System was completed in 1977, North Slope oil production is over 16.2 billion barrels (Alaska Division of Oil and Gas 2009). Estimates of remaining known recoverable oil resources from all discoveries on State lands east of NPR-A range in volume from about 2 to 7 billion barrels (Houseknecht and Bird 2005). Integrated geologic analyses of the oil reservoirs and source rocks, the kinds of hydrocarbons that were generated, the timing of generation, fluid migration paths and formation of traps indicates considerable oil and gas resources remain to be discovered.

Geologists assess oil and gas potential by defined geologic plays. Each play has unique characteristics relating to its prospective reservoirs, geologic history, current depth range, and connectivity to whatever hydrocarbons have been generated. Plays that underlie the coastal plain are perceived to be more oil-rich in the east (near commercial oil developments) rather than the west. Plays in the foothills region are predominantly gas plays, although, the area around the Umiat oil field unquestionably has some oil potential. Recent industry exploration has focused predominantly on the Beaufortian Alpine sandstone plays in the northeast part of NPR-A. One exploration well was drilled in the foothills. It encountered gas as was expected in the exploration plan.

Table 3-8 compares the results from several assessments of conventional technically recoverable oil and gas resources for the NPR-A. The assessment personnel, their methodologies, and resource calculating programs differ considerably. Consequently, the results are not directly comparable. The assessed resources of billons of barrels of oil and tens of trillions of cubic feet of gas indicate that the NPR-A has been determined to have considerable resources. Both oil and gas potential increased abruptly between the 1998 and 2002 USGS assessments, although the most recent assessment greatly reduced the oil potential in NPR-A. The 1976 and 1980 assessments are based on the results of the U.S. Navy and Husky exploration programs. Also, later assessments were based on analogs and the discoveries and developments on State lands east of the NPR-A.

Table 3-8. NPR-A oil and gas assessments for the NPR-A

Department of Interior assessment	**Estimated conventional technically recoverable hydrocarbon resources**					
	OIL (MMbbls)			**GAS (Tcf)**		
	95 %	**Mean**	**5%**	**95 %**	**Mean**	**5%**
U.S. Geol. Survey/1976, entire NPR-A	1.0	1.9	3.0	3.2	6.3	10.6
U.S. Geol. Survey/ 1980, entire NPR-A	0.3	2.1	5.4	1.8	8.5	20.4
MMS/ BLM 1998 NE Plan area only	1.8	3.1	4.7	3.2	9.9	21.7
MMS/ BLM 2002 NE and NW Plan areas only	6.8	9.1	11.8	23	37.3	56.2
Bird and Houseknecht, 2002 (federal), entire NPR-A	5.9	9.3	13.2	39.1	59.7	83.2
Bird and Houseknecht, 2002 (includes native and state waters), entire NPR-A	6.7	10.6	15.0	40.4	61.4	85.3
Houseknecht and others 2010, entire NPR-A		0.9			52.8	

MMbbls=millions of barrels, Tcf=trillions of cubic feet

The 1998 to 2002 assessments incorporated the discovery of Jurassic reservoirs and development technologies of the Alpine field and the results of earliest available industry exploration results. Extrapolation of data for the initial oil and condensate discoveries greatly influenced results of these assessments. Consequently, the oil and gas resources are considerably higher. The USGS 2010 update (Table 3-9) to the 2002 assessment incorporates all of the most recently publicly available data. Most of the seismic and well data are from the northern and northeast NPR-A. However, integration of the new seismic and drilling data has produced a 2010 assessment that reduces the estimated volume of technically recoverable oil.

The reasons for the reduction of estimates for resources include:

1. The new discoveries show that the Beaufortian plays are now considered to be predominantly gas bearing with subordinate volumes of oil.
2. The data indicate the NPR-A has been buried considerably deeper than previously thought. Consequently, the oil and source rocks have been thermally altered and a great volume of gas has been generated.
3. Exhumation (uplift and erosion) of the NPR-A has resulted in large-scale migration of the gas and the movement of previously reservoired oil.
4. The burial also degraded the porosity and permeability of the reservoirs.

Table 3-9. Table of NPR-A oil and gas resources by play, 2010

	Millions of barrels (MMbbl)				Billion cubic feet (Bcf)			
Plays	**F95***	**F50**	**F05**	**mean**	**F95***	**F50**	**F05**	**mean**
BROOKIAN								
Topset	21	107	249	**117**	0	300	1,079	**386**
Structural	0	0	654	**137**	4,801	10,119	18,012	**10,606**
BROOKIAN								
Clinoform N	49	241	557	**265**	0	870	2,502	**1004**
Clinoform C	0	104	352	**129**	0	1,926	5,235	**2,215**
Clinoform Ss	0	102	346	**127**	0	1,988	5,201	**2,253**
Clinoform Sd	0	0	0	**0**	0	3707	8,796	**3,788**
Torok structural	0	0	222	**35**	0	17,769	35,012	**17,905**
BEAUFORTIAN								
K Topset N	0	0	48	**8**	0	592	1,685	**670**
LJur (Barrow)	0	0	0	**0**	866	4,074	9,839	**4,552**
UJur Topset NE	0	26	80	**33**	829	2,415	5,254	**2,638**
UJur NW	0	0	0	**0**	251	967	2,211	**1,047**
ELLESMERIAN								
Ivishak	0	0	91	**21**	0	319	1,237	**416**
Echooka N	0	0	0	**7**	0	0	0	**7**
Echooka S	0	0	0	**0**	0	0	2,087	**505**
Lisburne N	0	0	60	**8**	0	0	938	**146**
Lisburne S	0	0	0	**0**	0	0	2,732	**646**
Endicott N	0	0	0	**3**	0	0	0	**1**
Endicott S	0	0	0	**0**	0	0	2,627	**544**
Ellesmerian structural	0	0	0	**0**	0	1,613	5,675	**1,990**
Thrust belt	0	0	43	**6**	0	1,327	4,240	**1,521**
Sum of means				**896**				**52,840**
Aggregated sum BB and TCF	0.07		2.7	0.9	6.75		114.36	52.84

* F95 represents a 19 in 20 chance that the assessed resource will be at least as large as the amount shown; other probability levels are defined similarly.

Source: Houseknecht et al. 2010

Additional exploration failures increased dry-hole probabilities and all of the noted factors have decreased the assessed oil resources.

The U.S. Geological Survey (USGS; Houseknecht et al. 2012) estimated the potential of undiscovered, technically recoverable shale oil and gas in the North Slope from 0 to 2 billion barrels of oil and from 0 to 80 trillion cubic feet of gas. A large range of uncertainty is associated with these assessment numbers because of the uncertainty estimating undiscovered, continuous resources in source rocks from which no attempt has yet been made to produce oil or gas. The assessed source rocks are the Triassic Shublik Formation, the lower part of the Jurassic-Lower Cretaceous Kingak Shale, and the Cretaceous pebble shale unit-Hue Shale (Brookian Shales). These formations generated oil and gas that migrated into conventional accumulations, including the super-giant Prudhoe Bay field, but also likely retained oil and gas that did not migrate. The shale oil is fairly evenly distributed between the Shublik and Brookian Shales, with significantly less potential in the Kingak Shale. The shale gas is concentrated in the Shublik Shale, with significantly less potential in the Brookian, and small gas potential in the Kingak.

Chapter III and Appendix 7 of the Northwest NPR-A IAP/EIS and USGS OFR 02-207 provide detailed discussions of the methodologies and geological inputs utilized in the assessments of technically recoverable oil and gas resources in NPR-A produced in 2002. The 2010 assessment utilizes the same methodologies of USGS OFR 02-207 with updated inputs.

Although the current estimated volume of technically recoverable resources is about 0.9 billion barrels of oil (mean), the aggregated sum of play resources at F05 probability level (1 in 20 chance) is about 2.7 billion barrels of oil[7]. The most recent USGS assessment shows that the probability of finding these resources is smaller and the task comparatively more difficult than previous assessments would have suggested. Industry exploration, however, is considerably more interested in the high side potential. However, the delays in achieving oil and gas development infrastructure in the NPR-A, along with the comparatively higher risk of success may alter industry's perception of the commercial development opportunities in NPR-A

The mean estimate of technically recoverable gas resources is slightly smaller in the 2010 assessment (52.8 trillion cubic feet) than in the previous assessment (61.4 trillion cubic feet, in Houseknecht and Bird (2002). The F05 total undiscovered gas resource is more than 114 trillion cubic feet. The Northeast NPR-A is closest to existing infrastructure and commercial oil fields on State lands just east of NPR-A. Natural gas resources occur in all plays across the NPR-A. The assessment shows that gas resource potential in the foothills and thrust belt is considerably greater than that of the northeast NPR-A These gas resources could be an important factor in establishing the reserves base needed to support the construction of a gas line from the North Slope.

3.2.7 Paleontological Resources

Most of the NPR-A is underlain by sedimentary rocks, typical of petroleum producing formations. As a result, the bedrock formations of the Reserve contain a wide array of plant and animal fossils. To date, the earliest fossil reported from within the NPR-A (Lindsey 1986) is the tooth plate of a lungfish recovered from a Middle Devonian formation which dates about 380 million years ago (mya). Most subsequent rock formations in the NPR-A exhibit some evidence of a fossil record.

Most of the limestone, sandstone, siltstone, conglomerate, and shale that underlies the NPR-A is marine in origin, and the fossils reflect this. By far, the most common fossils are brachiopods, cephalopods, gastropods, pelecypods, sponges, bryozoans, corals, and crinoids. It is in the middle part of the Jurassic Period, roughly 160 mya, that the first evidence of terrestrial plant fossils are noted—an indication of at least a temporary retreat of the ancient seas that previously had covered most of the region. Following this period the seas repeatedly advanced and retreated over most or all of the NPR-A. It is noteworthy that some of the one-hundred-million-year-old mid-Cretaceous rocks in the NPR-A produce some of the best examples of the flora of that period found anywhere in North America (Lindsey 1986). These plant fossils also document a change from a warm to a cool climate. It is at this time that modern conifers begin to appear on the North Slope. Most of the extensive fossil-bearing bedrock exposures in the NPR-A crop out in the Arctic Foothills and Brooks Range.

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[7] http://certmapper.cr.usgs.gov/data/noga00/natl/graphic/2010/summary_10_final.pdf

Late Cretaceous vertebrate fossils dating from 70 to 65 mya are also common in the NPR-A. Most of the known fossil deposits of this age are found in the extensive bluffs of the Colville River downstream from Umiat. Several mid-Cretaceous-age (110–90 mya) dinosaur trackway (footprints) locales have been identified on the Awuna and other Rivers and a 210 mya Upper Triassic Ichthyosaur's remains were located and recovered along the North Face of the Brooks Range from Cutaway Creek a tributary of the Kuna River. Other than a single hadrosaur bone found on Axel Heiberg Island, the dinosaur remains in the NPR-A not only represent the farthest north occurrence of dinosaurs in North America but account for about 99 percent of the known polar dinosaur remains worldwide.

Dinosaur remains were first noted (though originally misidentified as those of Pleistocene mammals) along the Colville River in 1961 in the vicinity of Ocean Point. Initial research at the Liscomb Bone Bed, named after the discoverer, was conducted in the early 1980s. Data gathered through this research brought to light new insights regarding dinosaur physiology, in terms of the un-reptile-like ability to survive in a cold, dark environment, and the impacts of the associated implications regarding dinosaur extinction theories (Brouwers et al. 1987, Paul 1988, Clemens and Nelms 1993, Gangloff 1997, Fiorillo and Gangloff 2000, Rich et al. 2002, Gangloff and Fiorillo 2010). Recent work in the Liscomb Bone Bed entailed digging a tunnel into the bluff just above the bone bed and subsequently retrieving material from the frozen matrix, which has not been impacted by seasonal freeze/thaw cycles (Rich 2008, Druckenmiller 2010). Preliminary analysis from this work appears to support the theory that Arctic Late Cretaceous dinosaurs were not migratory, but permanent residents of the region (Gangloff and Fiorillo 2010). In addition, the recent work has produced evidence of several species of dinosaur not previously known to be present in the Arctic and also the possibility of several new species that may be endemic to the Arctic (Druckenmiller 2010). These new findings are extremely significant and further emphasize that the value of this "world class" paleontological resource, which is the largest, most species comprehensive, polar dinosaur locale in the world, cannot be overstated. To date the following dinosaurs have been identified from the Liscomb Bone Bed: Hadrosaurus, Pachyrhinossaurs, Thescelosaurus, Troodon, Dromaeosaurus, Saurornitholestes, Tryannosaurus, and Ornithomimosaurus (Gangloff et al. 2005, Fiorillo et al. 2009, Druckenmiller 2010).

During the 1970s and 1980s, nearly 200 miles to the west of Liscomb along the Kuk, Kokolik, and Avingak Rivers dinosaur tracks and skin imprints were found. In 1998, additional trackways were found on the Awuna River, a Colville tributary more than 130 miles upstream of Liscomb. Some of these footprints were of dinosaurs not previously known to be present in the NPR-A.

Tertiary (65–1.6 mya) fossils in the NPR-A, a period when the region was regularly under water, are represented by mollusks, ostracods, brachiopods, and bryozoans. However, the record is incomplete due to a period of non-deposition and/or erosion that occurred during the Late Tertiary (Lindsey 1986).

The mammalian fossil remains most commonly found in the NPR-A date from 50,000 to 12,000 years ago, the final episode of the Pleistocene, and are abundant in many of the Quaternary deposits across the region (Guthrie and Stoker 1990, Hamilton and Ashley 1993, Matheus 1998, 2000, Matheus et al. 2003). Like dinosaur remains, most of the Pleistocene fossils are found as the result of stream erosion. The bones of horses, mammoths, antelope, bison, bears, lions, muskoxen, caribou, and moose are a resource of important data reflecting the climate, environment, and ecosystem that existed when the first humans entered the Western Hemisphere from the Old World (Kunz and Mann 1997, Kunz et al. 1999, Guthrie 2006, Mann et al. 2008, Kunz 2010). The genetic information in these fossils also provides valuable information regarding the impacts of and responses to episodes of past climate change on populations of Arctic megafauna (Groves et al. 2009).

3.2.7.1 Paleontological Resource Sites

Although the NPR-A is extremely remote and isolated, due to technological advances in aircraft and ground vehicles over the last 50 years the area has become more accessible. While some very limited paleontological resource data (exclusively Pleistocene-age fossils) was collected during the initial petroleum reconnaissance activities of the late 1940s and early 1950s, no planned data collection surveys were undertaken until the late 1970s, when the management of what was then known as Naval Petroleum Reserve Number Four was transferred to the Interior Department and renamed the National Petroleum Reserve-Alaska (Davis et al. 1981, Hall and Gal 1988). It was not until the early 1980s that bones collected along the Colville River by a Shell Oil geologist in 1961were identified as being dinosaur remains. Following that revelation, a number of universities and museums sent researchers to the region to conduct reconnaissance and engage in excavation. In the mid-1980s, the Bureau of Land Management supported a paleontological data search regarding the lands it managed in Alaska (Lindsey 1986). Most of the known dinosaur and other paleontological locations enumerated in Lindsey's study are listed in the Alaska Heritage Resource Survey. To date all known locales of dinosaur remains in the NPR-A are situated in stream cuts where erosion has exposed the fossils.

Fossil-bearing locales of Pleistocene mammals are more numerous than those of dinosaurs because they are much younger, Late Pleistocene in age (45,000–12,000 years ago), and in most cases not as deeply buried and therefore are more easily exposed. In most cases Pleistocene mammal remains are not fossilized (mineralized) and therefore are a good source of bio-molecular material, which can provide insights into past environmental conditions, and also can be dated very accurately by the radiocarbon method. Pleistocene fossils have been recovered from the Colville River and most of it tributary streams and from the Ikpikpuk, Titaluk, and Meade Rivers and their tributary streams (Matheus 1998, 2000). Pleistocene faunal remains have also been identified in deflated sand dunes of Pleistocene age on the coastal plain.

Pleistocene fossils have been recorded from all the physiographic provinces within the NPR-A, but are most common in the northern portion of the Arctic Foothills and the southern portion of the Arctic Coastal Plain Provinces. Known locales of dinosaur remains are relegated primarily to the Colville River and its southward flowing tributaries and to the Kuk River and its tributaries. It is probable that dinosaur remains are as ubiquitous across the NPR-A as are Pleistocene remains, but are buried too deeply to be exposed except under special circumstances. The principal reason that dinosaurs are known primarily from the Colville River is that a river the magnitude of the Colville is required to down-cut deeply enough to expose fossils of Cretaceous or greater age.

Most of the paleontological resources in the NPR-A are, by virtue of their isolation and remoteness, protected from most types of impact other than those caused by natural forces. The bulk of the deposits are deeply buried, the strata frozen and the landscape covered by snow nine months of the year and, therefore, well protected by nature. However, some of the known deposits are to a degree vulnerable, because they are often exposed in an eroding bluff face. In fact, were it not for these exposures, most paleontological deposits would not be discovered at all. However, the circumstances that lead to discovery in some cases allow unauthorized collection and the loss of valuable and important scientific and educational material. Most exposed bluff faces are formed through the erosional activity of rivers and streams. Fossils are commonly exposed or washed out of these bluff faces during annual high-water events. Even in an area as remote as the NPR-A, a river may provide access to a fossil bearing location through the use of a boat or by small aircraft that can land on gravel bars. Because of this unauthorized collection of fossil material can, but does not often occur, however the potential impact cannot be dismissed. Unauthorized collection is best deterred by a visible presence such as active research rather than irregular law-enforcement patrols (Gangloff 1997).

These paleontological resources are nonrenewable and contain a wealth of information about life forms, geography, and environments of the past, and they must receive adequate protection. Most of the paleontological resources of the NPR-A are yet to be located, and work toward that end is another important step in the protection of this resource.

3.2.7.2 Paleontological Resources and Climate Change

There is little doubt that climate change will cause alterations to the environment and habitats of the North Slope that could adversely affect paleontological resources (Scenarios Network for Alaska Planning 2010, Mann et al. 2010) although the degree to which this might happen remains unclear. Past episodes of climate fluctuation in Arctic Alaska have caused changes in vegetation coverage and type as well as the physical structure of the landscape itself (Mann et al. 2010). Both the deepening of the active layer and the thawing of near-surface permanently frozen ground, have, during episodes of past warming, initiated mass down-slope movement resulting in the erosion of hillsides, bluff faces, river banks and terraces (Mann et al. 2010), which, if they recur due to future climate change, could result in the partial or total destruction of paleontological sites located on those land forms. In addition, even when erosion does not occur, the deepening of the active layer and/or thawing of permanently frozen ground could result in decreased preservation of subsurface organic paleontological materials, particularly Pleistocene fossils. It should be noted however that in less dynamic circumstances erosion has exposed most of the known paleontological deposits in the NPR-A. In most cases, this type of natural impact is viewed as positive rather than negative, as it reveals the presence of sites usually with few negative results. Nonetheless, climate change will undoubtedly contribute to the exposure of more paleontological materials than has occurred previously and increased monitoring and collection is probably the best approach to saving the scientific/educational value of the resource.

Climate change will also cause the alteration of weather patterns and an increase in the frequency and intensity of spring and fall storms. Coupled with warming, storm surges are intensifying shoreline erosion along the Beaufort and Chukchi coastlines as well as the barrier islands. Although NPR-A's coasts are not known as areas that have produced much paleontological material, erosion is a potential concern. While it is possible that as a result of a decrease in seasonal ice cover, increased maritime activity along the coastal areas, in waterways, and lakes could result in the initiation of erosion due to boat wakes, although the possible impacts to paleontological resources are considered low.

It should be remembered that these potential climate change impacts will not be universal across Arctic Alaska. There are a myriad of factors involved that control the degree to which climate change can affect a specific location, region, habitat or ecosystem. Some locales may not be affected at all.

3.2.8 Soil Resources

3.2.8.1 Introduction

The information in the soils subsection was extracted from "Exploratory Soil Survey of Alaska" (Rieger et al. 1979). Much of this soil information is discussed in detail in the Northeast NPR-A IAP/EISs (BLM 1998, 2008) and Northwest NPR-A IAP/EISs (BLM 2003).

Soil information, and the associated map for the NPR-A planning area (Map 3.2.8-1), is based on the "Exploratory Soil Survey of Alaska" (Rieger et al. 1979). The exploratory survey and field mapping of the NPR-A planning area was initiated in 1967 and completed in 1973. Field mapping was done at a scale of 1:500,000 (1 inch equals about 8 miles). All existing soil maps and reports were used, but the exploratory soil map was based largely on observations made from a small helicopter that landed frequently in roadless areas. Distinctive landscape patterns were identified from the air and delineated on the map. Soils within each landscape segment were described and classified; relationships between the soils, the native vegetation, and landforms were noted; the proportion of the area occupied by each major type of soil was estimated. Each map unit in this survey represented an association of soils arranged in a consistent pattern. Delineations were based on the dominant soils in the landscape; however, other dissimilar soils were present within delineations. Refer to the "Exploratory Soil Survey of Alaska" for an in-depth description of individual soils and soil associations.

A primary purpose of soil surveys is to provide general soil information for land-use planning to predict soil behavior, hazards, and impacts for selected land uses. It is important to recognize that this exploratory survey did not provide the level of information required for intensive use of a particular area, as would be available in a more detailed soil survey.

Three major land resource areas have been identified in the NPR-A: the Arctic Coastal Plain, the Arctic Foothills, and the Brooks Range mountains (Map 3.2.4-1). Each major land resource area has a unique pattern of topography, climate, vegetation, and soils.

The "Exploratory Soil Survey of Alaska" (Rieger et al. 1979) provides a general statewide map of soil resources of Alaska. This document is used in this discussion to describe the major soil resources within NPR-A. Soils are classified and named based on soil taxonomy (USDA-Natural Resources Conservation service 2010). Map units consist of a number of soil components that are named at the subgroup level in this classification system. Nine map units occur in the NPR-A (Map 3.2.8-1). Since the "Exploratory Soil Survey of Alaska" was published, the USDA soil taxonomy has undergone numerous changes with the "11th Edition of the Keys to Soil Taxonomy," published in 2010, the most current version available. The Natural Resources Conservation Service (NRCS) has provided an up-to-date list of subgroup names based on this version. However, map unit symbols, soil properties, and other information remains unchanged.

3.2.8.2 Permafrost

The dominant factor in defining soils in the planning area is the presence of permafrost. Permafrost is defined as soil, sand, gravel, bedrock, or organic material that has remained below 32 °F for 2 or more years in succession (USDA 1999, p. 93). Almost continuous throughout the planning area, permafrost can exist as massive ice wedges and lenses in poorly drained soils or as a relatively dry matrix in well-drained gravel or bedrock. Depth of permafrost ranges from about 650 to 2,130 feet (200 to 650 meters) on the North Slope (National Research Council 2003, page 64). A borehole at a test site in the planning area (Awuna) at an elevation of 1,100 feet (336 meters) showed a permafrost depth of 969 feet (295 meters) (Clow and Lachenbruch 1998).

During the short arctic summer a portion of these soils thaw, between the top of the permafrost and the ground surface, forming a shallow unfrozen zone termed the active layer. This layer can vary from 8 inches (20 centimeters) to 6 feet (200 centimeters) on the North Slope depending on overlying vegetation and drainage (National Research Council 2003). The active layer at the Awuna test site in NPR-A showed an average late summer thaw depth of about 13 inches (34 centimeters) between 1998 and 2001 (Circumpolar Active Layer Monitoring Network 2005). On north facing slopes or in areas with heavy vegetative or litter cover the active layer may be only 6 inches (13 centimeters) deep.

Permafrost forms a confining barrier that prevents infiltration of surface water and may keep the active layer of soils saturated. Large wetlands are created even in areas of low precipitation. Decomposition rates are slow under these environmental conditions and organic matter tends to accumulate over the mineral soil parent materials as thick peat layers, particularly in low-lying areas (Nowacki et al. 2001). Cold temperatures and frozen conditions slow the process of soil formation, resulting in little profile development (Brady and Weil 1999). Lakes and streams in the Arctic Coastal Plain of the NPR-A influence the characteristics of the upper permafrost surface (USDOI BLM 1978a). Shallow lakes and streams that freeze completely in the winter are directly underlain by permafrost. Deep lakes greater than 7 feet in depth and major rivers typically do not freeze to the bottom in winter and are underlain by a thaw depression in the permafrost table.

Overlying vegetation serves as an insulating layer that prevents thawing of permafrost near the surface. Any disturbance that removes the overlying vegetation, or otherwise decreases its insulating capacity, can initiate melting of ice-rich permafrost and result in surface subsidence, (termed thermokarst). This disturbance can drastically alter the surface topography, hydrological regime, and temperature of the underlying soils. As the permafrost begins to thaw near the surface, it warms to greater depths and can form thaw ponds, gullies, and beaded streams. The hydrologic and thermal regimes of the soil are primary factors controlling the vegetation. Therefore, a disturbance to soils or vegetation, including fire, can initiate a long process of recovery with perhaps 20 to 50 years of cumulative impacts (Hinzman et al. 2000). Permafrost may provide a majority of the structural integrity of hillsides and shorelines including stream channel banks. Protection of the underlying permafrost is also a key component for any construction design. Ice content, and therefore the potential for subsidence, varies greatly between areas (National Research Council 2003, page 65).

The mean annual temperature in Alaska has increased 3.4 °F for the period between 1949 and 2004 (Alaska Climate Research Center 2004). Romanovsky and others (2004) have shown that the permafrost temperatures and active-layer thickness have increased along a transect of sites in Arctic and northwestern Alaska. The largest changes occurred near the coast, compared to sites further inland. This suggests that either coastal areas are more sensitive to change or that the forces driving the process of warming are greater in coastal areas. Continued long-term climate warming may accentuate these processes.

Soils in the planning area are underlain by permafrost, or permanently frozen ground, of varying thickness and as a result are continuously cold and water saturated. Except for the active layer, which lies between the top of the permafrost and the ground surface and thaws each summer, the ground is permanently frozen to about 660 to 1,330 feet on the North Slope (National Research Council 2003). Snow and ice typically cover soils for most of the year. Decomposition rates are slow under these environmental conditions and organic matter tends to accumulate over the mineral soil parent materials as thick peat layers, particularly in low-lying areas (Nowacki et al. 2001). Cold temperatures and frozen conditions slow the process of soil formation, resulting in little profile development (Brady and Weil 1999). During summer, the permafrost thaws to varying depths within the active layer (the depth of seasonal thaw), which typically occurs within a few feet of the soil surface. The presence of permafrost inhibits internal water drainage during the summer thaw, resulting in soils that are poorly drained and continuously wet.

3.2.8.3 Soil Units

The nine soil map units within NPR-A are described below in order of their acreage within NPR-A:

Map Unit IQ2 (s9256–8,671,140 acres) occupies most of the Arctic Foothills Province. It is extensive and widespread in all regions of the permafrost zone. Although the dominant soils have similar characteristics, there are some differences in associated soils of relatively minor extent, soil patterns, landforms, and landscape features. This unit occupies broad valleys, basins, foot slopes (lowest slopes of the Brooks Range), and low rolling piedmont hills. Most areas are patterned with polygons, stripes, and some circular frost scars. Elevations range from 300 feet above sea level near the coastal plains to 3,000 feet on foot slopes of the Brooks Range. Most of the soils are silty colluvial and residual material weathered from fine-grained, nonacid sedimentary rocks. The vegetation consists of tundra dominated by sedges, mosses, lichens, and low shrubs. This ice rich soil is generally not suited for development or construction purposes. This soil is described as Typic Histoturbels (see below for descriptions of soil types), loamy, nearly level to rolling association.

Map Unit IQ6 (S9277–6,422,970 acres) occupies most of the Arctic Coastal Plain which abuts the ocean across the north and the Colville River along the eastern edges of the planning area. With few exceptions, the soils of this unit are shallow and constantly wet as they lie over the area's thick permafrost. Elevations range from sea level to about 400 feet. Many small thaw (karst) lakes characterize this treeless area. Low terraces, broad shallow depressions, and floodplains are typical. It is common to find frost features, including polygons, hummocks, frost boils, and pingos. The dominant poorly drained soils have developed principally in deep loamy sediment under a thick cover of sedge tussocks, low shrubs, forbs, mosses, and lichens. Very poorly drained fibrous peat soils, commonly under a cover of sedges, occupy broad depressions, shallow drainage ways, and lake borders. These types of soils are cold and wet. The major soils are described as Typic Histoturbels, loamy, nearly level to rolling and Typic Fibristels, nearly level association.

Map Unit IQ21 (s9320–3,812,700 acres) occupies a large area in the center of the Arctic Coastal Plain in the planning area. The landscape is dominated by nearly level, low tundra, dotted by shallow thaw lakes. There are many undulating and rolling sand dunes, especially in areas bordering the floodplains of major streams and some of the larger lakes. Most of the dunes are stabilized by vegetation, though some dunes adjacent to streams are active. Elevation ranges from a few feet above sea level near the coast to about 150 feet inland. Sedges, mosses, grasses, lichens, and low shrubs and forbs dominate the arctic tundra in the area. Most of the soils consist of sandy aeolian, alluvial, and marine deposits, but a few soils were formed in loamy material. Poorly drained soils with a shallow permafrost table occupy most of the nearly level areas and the broad swales between dunes. The soils on dunes consist of aeolian sand and, although they are perennially frozen below a depth of 30 to 40 inches, they seldom retain enough moisture to form large ice crystals. The major soils are described as Typic Aquiturbels and Typic Psammoturbels, sandy, nearly level to rolling association.

Map Unit IQ8 (s9286–1,623,020 acres) occupies a narrow band on the hills and ridges of the Arctic Foothills Province north of the Brooks Range in the planning area. Broad sloping valleys, separated by steep ridges, hills, and knolls dominate the landscape. Elevations range from near sea level on a few foot slopes to about 3,000 feet on hills and ridges near the Brooks Range. Permafrost underlies all areas. The dominant soils in valleys and long foot slopes were formed from loamy colluvial sediment. Most of the soils on hills and ridges consist of very gravelly material weathered from sedimentary rock. A few soils near the Brooks Range were formed from very gravelly glacial drift. The vegetation consists of tundra made of mosses, sedges, lichens, grasses, dwarf shrubs, and small forbs. Vegetative patterns commonly stripe the long slopes and many frost-scarred areas mar hills and ridges. A few windswept peaks are nearly bare. The major soils are described as Typic Histoturbels, loamy, nearly level to rolling and Typic Aquiturbels, very gravelly, hilly to steep.

Map Unit MB 2 (S9396–753,660 acres) occupies a mid-slope strip along the north face of the Brooks Range near the southern edge of the planning area. The terrain is generally hilly to steep with high plateaus separated by deep valleys. Elevations vary from around 1,800 feet to over 4,000 feet on some of the low peaks. The dominant soils are formed in very gravelly drift or very gravelly colluvium of calcareous parent material. The entire area lies within the continuous permafrost zone and vegetation is described as tundra. The major soils are described as a Typic Molliturbels and Typic Aquiturbels, very gravelly, hilly to steep.

Map Unit IQ 24 (S9329–551,790 acres) occupies the southern end of the Arctic Foothills and is comprised of high ridges and narrow valleys with many rocky peaks. Elevations range from 1,500 to 4,200 feet. The soil is derived from glacial till in the valleys and colluvial material formed from local material on the slopes and ridges. Vegetation varies with aspect and elevation from low shrubs and sedge tussocks and mosses on lower elevations and north facing slopes to low shrubs, dryas, greases, and lichens at higher elevations and on south slopes. The entire soil unit is underlain by permafrost with ridges and south facing slopes that tend to be well drained while the remaining areas are generally poorly drained. Frost features such as frost boils, stone circles, and solifluction lobes are common. The major soils are described as Typic Aquiturbels and Typic Gelorthents, very gravelly, hilly to steep association.

Map Unit RM 1 (s9405–388,640 acres) occupies the highest elevations along the Brooks Range at the extreme south edge of the planning area. This is a rough mountainous area ranging in elevation from 300 to 5,000 feet that is comprised of steep rocky ground interspersed with glaciers. Where soils exist, they are very thin and stony over bedrock or boulder deposits but similar in properties to those of unit MB-2. Vegetation is sparse and mostly confined to lower slopes and along valleys. The material is generally suitable for

Definitions of Soil Subgroups

Typic Histoturbels: Soils with permafrost within 2 meters of the soil surface. Organic materials total over 20 centimeters in the upper 50 centimeters of the soil. There exists evidence of mixing by cryoturbation in one or more horizon in the profile.

Typic Aquiturbels: Soils with permafrost within 2 meters of the soil surface. Organic materials total less than 20 centimeters in the upper 50 centimeters of the soil. Saturated and reduced soil conditions exist near the surface for at least part of the year. There exists evidence of mixing by cryoturbation in one or more horizon in the profile.

Fluvaquentic Aquorthels: Soils with permafrost within 2 meters of the soil surface. Organic materials total less than 20 centimeters in the upper 50 centimeters of the soil. Saturated and reduced soil conditions exist near the surface for at least part of the year. Soils that are stratified mineral and organic soil horizons from periodic flooding.

Typic Gelorthents: Cold soils that do not have permafrost within 2 meters of the soil surface but have a mean annual soil temperature at 50 centimeters that is at or below 0 °C. Soils with weak horizon expression other than a thin A horizon.

Typic Haplogelolls: Cold soils that do not have permafrost within 2 meters of the soil surface but have a mean annual soil temperature at 50 centimeters that is at or below 0 °C. Nutrient rich soils with a dark surface mineral horizon over 20 centimeters thick with slightly acid through alkaline soil reaction throughout.

Typic Molliturbels: Soils with permafrost within 2 meters of the soil surface. Nutrient rich soils with a dark surface mineral horizon over 20 centimeters thick with slightly acid through alkaline soil reaction throughout.

Typic Fibristels: Soils formed in fibrous organic materials over one meter thick and have permafrost within 2 meters of the soil surface.

Typic Psammoturbels: Soils formed in sandy materials and have permafrost within 2 meters of the soil surface.

road construction in the valleys but large quantities of sediment commonly move away from the glaciated areas, making drainage structures difficult to maintain. The area is described as Rough Mountainous Land.

Map Unit MA 3 (S9392–290,470 acres) occupies the toe slope of the Brooks Range in the southeast corner of the planning area. The elevations vary from 1,800 to 3,000 feet in this area and include low hills and broad valleys characterized by moraines and outwash plains with many small lakes. The dominant soils have a dark humus-rich mineral surface horizon and are formed in glacial drift or colluvium. Only soils on gravelly moraines and steep hills are well drained. The entire area is within the continuous permafrost zone. Vegetation is described as tundra. The major soils are described as Typic Aquiturbels, very gravelly, hilly to steep and Typic Molliturbels, very gravelly, hilly to steep association.

Map Unit MA 3 (s9391−80,840 acres) occupies three drainages along the Nigu and Etivluk rivers in the southeast corner of the planning area at a major break in the Brooks Range. The elevations vary from 2,000 to 3,000 feet in this area. The dominant soils have a dark humus-rich mineral surface horizon and are formed in glacial drift or colluvium. Only soils on gravelly moraines and steep hills are well drained. The entire area is within the continuous permafrost zone. Sites are typically wind scoured with low snow accumulations and limited moisture (and frost) in the upper meter. Vegetation is described as sparse tundra. The major soils are described as Typic Aquiturbels, very gravelly, nearly level to rolling and Typic Haplogelolls, very gravelly, hilly to steep.

Map Unit IQ22 (s9322 and S9323−53,000 acres) occupies a large area along the Colville River through the Arctic Foothills and the Arctic Coastal Plain along the eastern boundary of the planning area (576,900 acres) however the river below the high-high water line on the west and north sides of the river is outside of the planning area. Only approximately 53,000 acres along the river are above the high-water mark and lie within the NPR-A and should be considered lands covered by this management plan. It occupies low terraces, braided floodplains, and broad alluvial fans bordering the Colville River. Elevations range from sea level on the plains bordering the coast to about 2,000 feet in the Brooks Range. The dominant soils consist of very gravelly stream deposits underlain by permafrost. A general decrease in grain size is evident along the topographic gradient descending from the Brooks Range, extending laterally from fluvial systems and radiating inward from lakeshores to center (Jorgenson and Pullman 2002). Low parts of the unit are commonly flooded by runoff from spring snowmelt and heavy summer rainstorms in the mountainous watershed areas. The vegetation consists of arctic tundra dominated by sedges, mosses, and low. This soil is described as Fluvaquentic Aquorthels, very gravelly, nearly level association.

3.2.8.4 Soils and Climate Change

There are predictions that climate change will continue to warm and dry NPR-A from the historically recorded ranges. Warmer temperatures are not likely to accelerate the soil forming processes significantly enough to measure the change during the period covered by this plan. Soil formation is a very slow process. The climate will remain relatively cool with long periods of freezing and low solar angles. As soils dry out, there is also a reduction in the chemical reactions that aid in soil formation.

Climate change may affect the depth of permafrost in the soil profiles, as indicated by Scenarios Network for Alaska Planning (2010). As indicated in Table 3-10, the top of the permafrost layer will likely recede below the surface very slowly, increasing the thickness of the soil profile that melts and freezes on an annual basis, which is called the active layer. This may allow the water table to drop further below the surface of the soil and in some locations this may allow the water to drain out of the profile since many of the soils are high in organic matter and low in mineral content.

Table 3-10. Estimated depth of active layer, 1980s to 2090s (feet)

Timeframe	All NPR-A	NPR-A's coastal plain	NPR-A's foothills	NPR-A's mountains
1980s-2000s average	1.709	1.322	2.037	2.421
2040s	1.936	1.486	2.313	2.802
2090s	2.280	1.814	2.657	3.396

Source: SNAP 2010

As the active layer deepens, there are more opportunities for plants to send roots deeper into the profile. This may allow plant communities to begin migrating further north within their ranges. In some instances, the lowering of the water table may result in a gradual shift in plant communities to species that are better suited to a dryer site and away from those species that are tolerant of high water content in the soil profile. These processes are not expected to occur rapidly and may take a hundred years or more to shift the ecological composition appreciably. These changes in vegetation will promote soil formation through greater root development and contribution of additional organic matter to the soil profile.

Structurally the increase in the depth of the active layer is expected to have a negative effect on the ability of the soils to carry loads. Any traffic over the surface during non-frozen periods would be expected to create more damage than under the present conditions. This may result in deep ruts and severe channeling of water into the vehicle tracks. Such concentration of water would be likely to accelerate erosion and create new drainage channels that drain water from the surrounding areas. It also would be likely to accelerate the subsidence of the permafrost in the track areas. Similar subsidence has been observed in tracks from early exploration of the region in the 1960s in many other areas of the tundra.

3.2.9 Sand and Gravel Resources

Large volumes of mineral materials (sand, silt, gravel, and common rock) are required for oil and gas production to develop basic infrastructure such as access roads, development pads, airfields, pipelines, docks, and support facilities. Permanent facilities are generally large consumers of these materials. The development of temporary infrastructure supporting energy exploration and pre-development activities, which are typically permitted during the long arctic winter, can make almost exclusive use of ice roads and pads to provide this infrastructure. The decision to use either of these resources, mineral materials or water (ice), is based on the economics of obtaining them.

The initial development of the State of Alaska's Prudhoe Bay oil resources and construction of the Trans-Alaska Pipeline east of the NPR-A relied largely on sand and gravel resources removed from of the Sagavanirktok and other large North Slope river systems, in addition to more limited coastal and inland gravel sources (Alaska Department of Fish and Game 1993). Local floodplains are generally the first mineral material sources tapped for new developments due to lower operating costs and efficiency (Joyce et al. 1980). In recent years, there has been a directive to reuse/recycle gravels from abandoned access road's and exploration pads to support further development in the area. This is partially due to the general scarcity of suitable material and an attempt to limit additional mining activities in river systems.

3.2.9.1 Sand and Gravel Deposits

The surface materials of the NPR-A Arctic Coastal Plain include upland silts, thaw lake deposits, alluvium and fluvial-lacustrine deposits, and eolian sands, derived from the local sandstones, limestones, and shales. Similarly, the surficial deposits of the Arctic Foothills Province are composed of eolian sand and upland silts and an undifferentiated bedrock of sandstones, shales, and conglomerates. Eolian sand and upland silts are the most widespread unconsolidated sediments in the entire NPR-A. These sand and silt deposits may be ice-rich and not suitable for foundations when thawed. Coarser grained alluvium (including gravel) is found along the river systems in the southern portions of the NPR-A.

Currently, the only existing or previously utilized sand and gravel sites within the NPR-A are located around the villages. Map 3.2.9-1 shows the surficial geology of the NPR-A. Table 3-11 describes the mapped units.

Table 3-11. Description of mapped units for the surficial geology of the NPR-A

Geologic unit	Description
Qcb	Modern coastal beach deposits (sand to silt)
Qfp	Modern floodplains (sand to silt)
Ql	Modern lakes (mainly silt)
Qcc	Older coastal deposits of alluvial and marine sediments (sand to silt)
Qra	Dominantly course rubbly deposits associated with steep-sloped mountains with higher percentage of bedrock exposures (talus slopes with course grained sand to boulders)
Qrb	Course and fine-grained deposits associated with moderate to steep-sloped mountains and hills with bedrock exposures largely restricted to upper slopes and rubble on crestlines (course grained sand to boulders)
Qrc	Fine-grained deposits associated with gently sloping hills with rare bedrock exposures (sand to silt)
Qe	Silt more then 5-feet thick (silt)
Qm3	Prominent, slightly modified, glacial moraines and associated drift
Qm1	Remnants of highly modified glacial moraines and associated drift

West and north of the Colville River within the NPR-A, the coastal areas are characterized by an apparent scarcity of suitable construction materials. The southern portion of the NPR-A contains more abundant sand and gravel resources. The source of these sediments is the Brooks Range, from which the wind and water-transported materials were originally eroded. Again, the most suitable materials for NPR-A development would be found in the area's larger river systems. However, as one moves north away from the Brooks Range sediment sources, the materials become finer-grained and thus less suitable for use as construction materials. As noted earlier, the vast majority of transported sediments on the North Slope are derived from soft sediment lithologies like sandstone, shale, and limestone, and as a consequence, produce poor quality construction materials. As a result, significant volumes would be required periodically for maintenance of any existing infrastructure. Where available, quartz-rich bedrock, such as quartzite, quartz-cemented conglomerate, and intrusive rocks (i.e., granite), represent a more durable and desirable gravel or crushed rock source.

3.2.9.2 Regulatory Environment

Sand and gravel in the NPR-A are treated as subsurface-mineral resources owned by the federal government. Passage of the 1976 Naval Petroleum Reserves Production Act (NPRPA) allowed for the use of this resource to meet the needs of the permitted activities within the Petroleum Reserve. The Secretary of the Interior is authorized to dispose of mineral materials for use by Alaska Natives, the North Slope Borough, and in energy production and development, to grant such rights-of-way, licenses, and permits as may be necessary to support these permitted uses. The use of sand and gravel for other purposes would require additional legislation.

3.2.9.3 Sand and Gravel and Climate Change

Climate change will not affect the existence or location of the mineral material deposits within the NPR-A. Techniques for accessing and extracting those resources would have to take into consideration mine development in a changing climate.

Mining in Alaska, particularly in the northern latitudes, involves the use of ice roads, snow trails, and ice pads for transportation of equipment to and from the mineralized location, usually during the exploration and mine development phase. As the climate changes, the methods of mining and exploration might change as well. A warmer climate could lengthen the mining season while a cooler climate could shorten the mining season, or force a change in the mining methods to allow mining during the winters. A longer or warmer summer season may increase the volume of materials needed to maintain infrastructure.

When developing a mineral material pit, there are a multitude of factors to take into consideration. Attempting to second-guess the future of the climate throws an entirely different set of variables into that development process. Depending on the type of material and the mining method used to extract that material, a changing climate could make the excavation easier, due to the melting of the permafrost, or more difficult when attempting to develop deposits in areas with melted permafrost, which may necessitate removing water, or the need to excavate in swampy conditions.

3.2.10 Water Resources

Water resources in the planning area consist mainly of rivers, shallow discontinuous streams, lakes, and ponds. Springs are absent in the planning area, and useable groundwater is limited to shallow resources beneath rivers and lakes. Deep groundwater is saline and not potable. Climate and permafrost are the dominant factors limiting water availability.

3.2.10.1 Surface Water Resources

While hydrologic data for the planning area section of the North Slope is limited, streams and rivers for which data are available share flow characteristics that are somewhat unique to the region (Brabets 1996). Flow is generally nonexistent or so low as to not be measurable most of the winter. River flow begins during break-up in late May or early June as rapid flooding that, when combined with ice and snow, can inundate extremely large areas in a matter of days. More than half of the annual discharge for a stream can occur during a period of several days to a few weeks (Sloan 1987). Most streams continue to flow throughout the summer, but at relatively lower discharges. Runoff is confined to the upper organic layer of soil, as mineral soils are saturated and frozen at depths of 2 to 3 feet (Hinzman et al. 1993). Rainstorms can increase streamflow, but they are seldom sufficient to cause flooding within the Arctic Coastal Plain. Streamflow rapidly declines in most streams shortly after freeze up in September and ceases in most rivers by December. Streams on the North Slope are generally divided into three types, based on the physiographic province of their origin: those that originate (1) on the Arctic Coastal Plain, (2) in the Arctic Foothills, or (3) in the Brooks Range (Table 3-12 and Map 3.2.4-1).

Table 3-12. Summary of hydrologic data from past and present gauging stations in the NPR-A

Stream location	Headwaters	Drainage area at gage (mi^2)	Peak flow (cfs)[1]	Period of record
Colville River (near Nuisqut)	Brooks Range, Foothills	20,670	580,000	1977
Colville River (Umiat)	Brooks Range, Foothills	13,830	261,000	2002–present
Otuk Creek at Ivotuk	Brooks Range, Foothills	54.0	1,740	2000, 2003–present
Ikpikpuk River below Fry Creek	Foothills	1,700	28,800	2002–present
Prince Creek near Umiat	Foothills	225	5900	2009–present
Seabee Creek at Umiat	Foothills	NA	550	2007–present
Judy Creek (mile 7)	Foothills, Coastal Plain	639	7,100	2001–present
Meade River near Atqasuk	Foothills, Coastal Plain	1780	43,200	1977, 2005–present
Nunavak Creek at Barrow	Coastal Plain	2.79	131	1971–2004
Miguakiak River	Coastal Plain	1,460	1,600	1977
Fish Creek (mile 32)	Coastal Plain	787	3,700	2001–present
Ublutuoch R River (mile 13.7)	Coastal Plain	222	5,300	2001–present

[1] Cubic feet per second. (Sources: Arnborg et al. (1967), Childers et al. (1979), Kostohrys (2003), Shannon and Wilson Consultants (1996), USDOI BLM (2004c), USGS NWIS web interface http://waterdata.usgs.gov/ak/nwis/sw)

Arctic Coastal Plain

The Arctic Coastal Plain is a mosaic of tundra wetlands with extremely low relief. Because the permafrost prevents water from entering the ground and the low relief limits runoff, the Arctic Coastal Plain is covered with lakes, ponds, and generally slow-moving streams. Streams originating in the Arctic Coastal Plain generally have the latest break-up and earliest freeze up and generally cease flowing by December. The most significant coastal rivers and streams in the NPR-A are the Avak, Tunalik, Ivisaruk, Kungak, Kugrua, Kuk, Nigisaktuvik, Inaru, Miguakiak, Kalikpik, and Ublutuoch (Tingmiaksiqvik) rivers, and Fish, Kealok, and Inigok creeks.

Arctic Foothills

Streams originating in these Arctic Foothills have a steeper gradient and consequently more gravel bar and cut bank features than those on the Arctic Coastal Plain. These streams tend to break up earlier, freeze up later, and have a slightly higher average unit runoff than streams of the Arctic Coastal Plain. Shallow water tracks may result from snowmelt draining through the permafrost features, often conveying significant discharge where surface relief is limited (Hinzman et al. 1993). The larger river systems break up into distributary channels once they approach the mouth or exit the Foothills and flow distributions can vary widely in these channels.

The Ikpikpuk River, which originates in the Arctic Foothills and is centrally located in the NPR-A, has two major distributary channels, the Chipp and Alaktak rivers which flow into Admiralty Bay. In 2002, streamflow measurements indicated that three-quarters of the flow passing by the Ikpikpuk River gauge (1,985 cubic feet per second [cfs]) left the main channel into the Chipp River (1,540 cfs). Further downstream, two-thirds of the remaining flow then flowed into the Alaktak River (440 cfs), leaving approximately 10 percent of the remaining flow at the mouth of the Ikpikpuk River (220 cfs) just above the Miguakiak River which flows into Smith Bay.

Other large streams originating in the Arctic Foothills include Shaningarok, Maybe, Fry, Alice, Key, Judy and Prince creeks, and Kaolak, Ketik, Meade, Avalik, Awuna, Usuktuk, Topagoruk, Oumalik, Titalik, Kigalik, Price, Kikiakrorak, and Kogosukruk rivers.

Brooks Range

The crest of the Brooks Range and the Colville River form most of the southern and eastern boundaries of the NPR-A. The Colville is the largest river on the North Slope and intercepts all of the streams originating in the Brooks Range that flow northward through the Reserve for 275 miles from the headwaters in the west to the Itkillik River in the east. Storms centered over the Brooks Range and rain-on-snow events have been known to generate rises of 8 to 10 feet in 24 hours at the gaging station at Umiat. As the only river that includes mountainous and glacial drainage, the Colville River carries the highest sediment load and exhibits the greatest range of geomorphic features of any river in the area. Steep cut bank cliffs, deep pools, and large gravel bars are common to most of the rivers in this part of the Reserve. Break-up and freeze-up are more complex along the Colville River because of the extreme length and range of elevation. Flow persists later on the Colville River than on other North Slope rivers in the planning area. Other large rivers originating in the Brooks Range include the Kokolik, Utukok, Nuka, Kiligwa, Kuna, Ipnavik, and

Etivuluk rivers. Major rivers draining into the Colville River from the east include the Killik, Chandler, Anaktuvuk, and Itkillik rivers.

Lakes

Lakes and ponds are the most common feature on the Arctic Coastal Plain and are scarce within the Foothills and Brooks Range. Unlike streams, which only hold large quantities of water during breakup, lakes store water year-round and are the most readily available water source on the North Slope (Sloan 1987). The origin of most lakes and ponds on the Arctic Coastal Plain is in the thawing of ice-rich sediments (Sellman et al. 1975). This thawing results in a continuum known as the thaw lake cycle, in which lakes form, expand, and then drain in response to disturbances of the permafrost. Because waterbodies less than 6-feet deep generally freeze to the bottom most winters, lake depth is the primary factor in winter water supply. Lakes can then be classified by depth, as either shallow (less than 6 feet) or deep (greater than 6 feet) lakes. Mellor utilized Side Looking Airborne Radar images to map lake depths in the NPR-A and was able to identify lakes which were shallower than 1.6 meters (5.2 feet) and deeper than 4 meters (13 feet) depth (Mellor 1987) (Map 3.2.10-1).

Recharge of lakes in the NPR-A occurs through three mechanisms: (1) melting of winter snow accumulations within a drainage basin, (2) overbank flooding from nearby streams, and (3) rainfall precipitation (Baker 2002). Some lakes are completely replenished by these processes within 1 year; water volumes in other lakes have much longer residence times, perhaps as long as 25 years (USDOI BLM and MMS 2003). Lake evaporation is also extensive in this region. From June to August (1994 to 1996), an average of 5.6 inches (14.1 centimeters) of evaporation was recorded for ponds near Prudhoe Bay (Mendez et al. 1998).

Shallow Lakes and Ponds

Seasonally flooded wetlands, ponds, and shallow lakes (less than 6 feet deep) dominate the Arctic Coastal Plain of the planning area. These wetlands, lakes, and ponds are thought to originate in the thawing of the shallowest, ice-rich permafrost layer. The shallow lakes and ponds freeze in mid-September and become ice-free in mid-June, about a month earlier than the deep lakes (Hobbie 1984). While ponds and shallow lakes generally lack fish because they usually freeze solid, they can provide important summer rearing fish habitat if they have a channel connecting them to a stream or deep lake that supports overwintering fish. They also provide important habitat to emergent vegetation, invertebrates, and migratory birds due to the earlier availability of ice-free areas.

Deep Lakes[8]

Teshekpuk Lake and the southern and western areas of the Arctic Coastal Plain contain numerous deep-lake basins (Mellor 1987). Most deep lakes are less than 20-feet deep, since the depth of thaw lakes appears to be controlled by the ice volume and porosity in the original sediments, which decrease with increasing depth (Sellman et al. 1975). Teshekpuk Lake, the largest lake on the North Slope with an area of 315 square miles, provides a great diversity of habitat types. Besides the central basin with a depth greater than 20 feet, the lake has complex shoreline features with bays, spits, lagoons, islands, beaches, and extensive shoal areas that support wildlife. Because they do not freeze to the bottom, deep lakes provide an overwintering area for fish and aquatic invertebrates and are the most readily available supply of water during the winter.

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[8] Deeper than 6 feet

Lake Water Use

Oil exploration activities in the NPR-A use ice roads and pads for access and transportation during the winter months. Each season, millions of gallons of fresh water are withdrawn from lakes to construct ice roads and pads. Approximately 513 million gallons of water from 126 lakes were used to drill 20 wells and construct 23 ice drill pads and roads between 1999–2006 (USDOI BLM 2006). Water withdrawal begins as early as December and continues through April. Ice roads are usually completed by mid-winter; however, water withdrawals for ice road and pad maintenance continue throughout the exploration season. In addition to ice roads and pads, freshwater lakes are used as potable water supplies for temporary rig and exploration camps and as sources of make-up water for exploration drilling (Baker 2002).

Generally, water withdrawals during winter from lakes 7-feet deep or deeper are limited to 15 percent of the estimated free-water volume remaining below the ice. Lakes deeper than 5-feet deep may allow up to 30 percent of the under ice water to be removed if only resistant fish species (i.e., ninespine stickleback and Alaska blackfish) are present.

Estuarine Waters

The NPR-A includes several estuaries. The basic characteristics of the bays and coastal waters are summarized in reports by Barnes (1984), and the OCS Environmental Assessment (NOAA Outer Continental Shelf Environmental Assessment Program 1978, 1987, 1988; NOAA Outer Continental Shelf Environmental Assessment Program and Minerals Management Service 1984). These reports state that all of the NPR-A bays and lagoons are very shallow and are shoreward of the 33-foot (10-meter) isobath (line of equal bathymetry or water depth). The circulation in this shallow water during the summer is wind-driven and rapid. Circulation is very slow under the winter ice cover. When seawater freezes, only the water molecules form ice; the salt is cast off as brine into the underlying water column. The brine does not drain or flush out of the shallow bays. Instead, it collects on the seafloor, gradually raising the salinity level from 32 to over 100 parts per thousand in some seafloor depressions (Schell 1975, Newbury 1983). The coastal waters off the NPR-A, like all Alaskan coastal waters, have pristine water quality in the estuaries (Arctic Monitoring and Assessment Programme 1997).

Sea Ice

Observed sea ice trends and global circulation model simulations show coastal Arctic regions to be increasingly ice-free or nearly ice-free for longer summer and autumn seasons (Intergovernmental Panel on Climate Change 2007).

The formation of first-year sea ice, signaling the start of freeze-up along the Beaufort Coast, may start as early as the beginning of September or as late as December. During the first part of freeze-up, nearshore ice is susceptible to movement and deformation by modest winds and currents. Movement may be a mile or more per day, and deformation may take the form of ice pileups and rideups on beaches and the formation of offshore rubble fields and small ridges. Ice rideups occur when a whole ice sheet slides in a relatively unbroken manner over the ground; rideups greater than 160 feet are not very frequent. By late winter, first-year sea ice is about 6 to 7 feet thick. In waters 6 to 7 feet deep, the ice freezes to the seafloor and forms the bottomfast-ice subzone of the landfast-ice zone. The landfast-ice zone may extend from the shore out to depths of 45 to 60 feet. The ice in water depths greater than about 6 or 7 feet is floating and forms the floating fast-ice subzone. As the winter progresses, extensive deformation within the landfast-ice zone generally decreases as the ice thickens and strengthens and becomes more resistant to deformation.

Along the Beaufort Sea coast, break-up generally begins about mid-July but may occur in mid-June or late August. River ice begins to melt before the sea ice and, during the early stages of break-up, water from rivers may temporarily flood ice that has formed on deltas.

3.2.10.2 Surface Water Quality

Most freshwaters in the planning area are pristine and, like those of Teshekpuk Lake, are soft, dilute calcium-bicarbonate waters. Near the coast, sodium chloride (salt) concentrations predominate over bicarbonate concentrations (USDOI BLM NPR-A Task Force 1978a, Prentki et al. 1980). The freeze/thaw cycle in the Arctic plays a controlling role in water quality. In winter, surface waters less than 6-feet deep will freeze solid (Hobbie 1984). In such waters, major ions and other "impurities" are excluded from downward-freezing ice in autumn and forced into the underlying sediment. Most of the ions remain trapped in the sediment after the next spring's meltout, giving these waters a very low dissolved matter concentration. During the summer, dissolved matter concentrations slowly increase as ice in the bottom sediment melts and the sediments compress (Miller et al. 1980).

In waters deeper than 6 feet, ions are forced into the deeper water column with a proportionate increase in concentrations of dissolved materials. As a result, distinct off-flavor and saline taste affect the potability of water from shallower "deep-water" lakes and river pools by late winter.

Potability

Ponds and local streams are highly colored from dissolved organic matter and iron; the water tastes fine but is considered marginally potable to unpotable because of iron staining and fecal contamination in areas with dense avian (Ewing 1997), caribou, and lemming populations. Lemming fecal material generally is abundant in upper coastal tundra soils (Gersper et al. 1980). Cold temperatures, a characteristic of tundra soils and waters, tend to prolong the viability of fecal coliform, the standard water-quality measure for fecal contamination. Thus, some smaller waterbodies in the NPR-A may exceed State of Alaska standards for fecal coliform in drinking water or water recreation due to local wildlife abundance (there is no state standard applicable to growth and propagation of natural aquatic life or wildlife). Lakes and larger rivers tend to be less colored and would be less likely to be contaminated with fecal coliform. Teshekpuk Lake, the Miguakiak River, the upper Colville River, and the Ikpikpuk River may receive some human fecal coliform contamination because of the increase in unregulated long-term campsites and cabins without adequate sewage disposal; however, impacts would not significantly raise levels in the lake or be measurable except in very localized situations.

Turbidity

Most NPR-A freshwater areas have low turbidity or suspended-solid concentrations. The exceptions are the larger rivers, possibly shallow floodplain lakes, and waters from thermokarst erosional features. Thermokarst is an altering of the terrain caused by melting permafrost that results in subsidence and water pooling.

Approximately 70 percent of the sediment load for the Colville River is carried during break-up, with suspended-sediment concentrations reaching 870 milligrams per liter (USDOI BLM 1978a). Later in summer, suspended-sediment concentrations decrease to as low as 3 parts per million. The Colville River, with its origins in the foothills of the Brooks Range, carries a greater suspended load than rivers originating within the Arctic Coastal Plain, and it is the most turbid river in the Arctic Coastal Plain of the NPR-A. Other rivers in the NPR-A range from about 100 parts per million suspended sediment at peak-flow rates down to 3 to 10 parts per million at lower flow rates.

Alkalinity and pH

Alkalinity and pH are important parameters in controlling the susceptibility of freshwaters to acid rain or acid snowmelt. Alkalinity is a measure of the acid-buffering capacity of the water. The pH is a measure of the hydrogen ion concentration in the water. A pH of 7 indicates a neutral balance of acid and base in the water, a pH between 5.0 and 6.5 indicates slightly acidic water, and a pH below 4.5 indicates acidic water. The State of Alaska considers a pH range within 6.5 to 9.0 necessary to protect aquatic wildlife. Most surface waters have a pH ranging from 6.5 to 8.5. Rainwater has a pH of 5.5 due to carbon dioxide in the atmosphere. Plants and aquatic life tend to buffer the pH of surface waters and keep the pH in the range of 6.5 to 8.5.

In the NPR-A Arctic Coastal Plain, freshwaters are weakly buffered (USDOI BLM 1978a, Prentki et al. 1980, Hershey et al. 1995, O'Brien et al. 1995). Lake alkalinities also are low, approximately 0.5 milliequivalents/liter (meq/l). Alkalinities in individual NPR-A coastal rivers are higher, ranging from about 0.3 to 1.6 meq/1 in summer, with higher values at lower flow rates. In ponds, pH values are often depressed to below a pH of 7.0 due to snowmelt runoff. After snowmelt, their pH values usually increase to between pH 7.0 and 7.5 (Prentki et al. 1980). The initial low pH is due to acidity of snow on the North Slope, which has a median pH of 4.9 (Sloan 1987). This low pH, lower than the pH of 5.5 expected for uncontaminated precipitation, is thought to be a result of sulfate fallout from industrially contaminated Arctic air masses. In lakes, pH values are near neutral (O'Brien et al. 1995). In tundra brown-water streams and some foothill streams, pH values can be less than 6.0, with an acidity attributable to naturally occurring organic acids (Hershey et al. 1995, Milner et al. 1995, Everett et al. 1996). In tundra rivers, pH values are higher, seasonally ranging between 6.4 and 8.2 in the Colville, Meade, Chipp, and Miguakiak rivers (USDOI BLM 1978a).

Dissolved Oxygen

Most of the world's surface waters are near saturation with dissolved oxygen due to aeration of flowing waters. The concentration of dissolved oxygen in Arctic waters tends to be higher than in other waters because the solubility of oxygen increases with decreasing water temperature. In deeper NPR-A coastal plain lakes, waters remaining beneath the ice may become supersaturated with oxygen in winter (USDOI BLM 1978a, Prentki et al.

1980, O'Brien et al. 1995). During ice formation, dissolved oxygen is excluded from the ice into the water column. Exclusion adds more oxygen than underwater respiration removes. In shallower lakes, dissolved oxygen measurements taken below ice do not show consistent results from year to year and do not generally remain saturated. Lakes sampled in the Nuiqsut area during winter were found to be stratified within the water column and levels were often no more than 1 to 2 milligram per liter within the bottom 1 to 2 feet of the water column (Hinzman et al. 2006) Consumption of dissolved oxygen is mostly due to bacterial respiration and chemical oxidation at the sediment/water interface and fish in the water column only contribute minimally to the depletion (Stefan 1992).

Sources of Surficial Oil and Hydrocarbons in the NPR-A

The NPR-A has known oil seeps at Skull Cliff, Dease Inlet, Cape Simpson, Umiat and Fish Creek, which were described and analyzed by Ebbley (1943). The peat that underlies the North Slope carries a high hydrocarbon content. This content is evidenced by natural sheens that occur in ponds or flooded footprints in the tundra, in the foam on the downwind shoreline of lakes on windy days, and by elevated hydrocarbon levels in sediments with peat. The Colville River drainage includes coal and oil-shale outcrops, the oil seeps, and peat. An oil seep at Umiat along the Colville River led to early Navy exploration at that site.

Indicator Hydrocarbons

Pond waters away from development in the Prudhoe Bay area contain 0.1 to 0.2 parts per billion total aromatic hydrocarbons, similar to concentrations in pristine marine waters (Woodward et al. 1988). Concentrations in NPR-A waters are expected to be similar. Hydrocarbons derived from various natural-occurring sources are detectable as elevated levels of saturated and polycyclic aromatic hydrocarbons in Colville River sediment and in Harrison Bay sediment (Boehm et al. 1987). Additional pyrogenic polycyclic aromatic hydrocarbon compounds are present in tundra soils and form a depositional record of atmospheric fallout from tundra fires. Concentrations of indicator hydrocarbons from these multiple sources are high and chemically similar to those found in petroleum, thus making it difficult to detect or distinguish anthropogenic contamination from natural background due to fires. Similarly, high levels of hydrocarbons found in other major Beaufort Sea rivers have been attributed to natural sources (Boehm et al. 1987, Yunker and MacDonald 1995).

Trace Metals

Aquatic bodies in the NPR-A are, in general, low in trace metals compared with most temperate freshwaters (Prentki et al. 1980). In measurements made in ponds near Barrow in 1971–72, dissolved copper concentrations were on the order of 1 part per billion, dissolved lead 0.7 part per billion, and dissolved zinc 5 parts per billion. Lakes sampled west of Nuiqsut during early 2002 found non-detect levels of arsenic, cadmium, chromium, lead, selenium, silver, and mercury (Baker 2002). Higher levels of trace metals have been observed in waters draining known zinc-lead-silver deposits in the Drenchwater Creek area, 76 miles west northwest of the Ivotuk airstrip. Other smaller zinc-lead-silver deposits occur in the upper portions of the Kuna, Ipnavik, Etivluk and Nigu drainages (Kurtak 1995) and could also possibly result in elevated trace metals in those waters.

Leaching and weathering of the Drenchwater deposit has affected the natural water chemistry of the three streams in proximity to the Drenchwater deposit; Drenchwater

Creek, Discovery Creek, and False Wagner Creek. High specific conductance and low pH values were also associated with the ore body (Table 3-13). The low pH and high total-metal contents of waters from the Drenchwater deposit are similar to those from the Red Dog deposit prior to mining, although the total metal concentrations in water from the Red Dog deposit are many times greater than at Drenchwater. In contrast, water samples below the mineralized zone at the Lik deposit have pH values of 6.2 to 8.1 and, with the exception of zinc, the metal contents are low compared with water draining the Drenchwater deposit. Carbonate rocks present at Lik likely serve to buffer acidic, metal-rich waters (Kelley 1995). The Lik deposit is located 12 miles northwest of Red Dog Mine.

Table 3-13. Comparisons of water chemistry samples from the Lik, Red Dog, and Drenchwater deposits upstream and downstream of the ore deposits

Deposit	No. of samples	pH	Specific con-ductance uS/cm	Cd ppb	Co ppb	Cu ppb	Ni ppb	Pb ppb	Zn ppb	SO_4^2 ppm
Upstream of the deposit										
Lik[1]	6	7.5	300	< 1	< 3	< 10	< 5	< 10	12	50
Red Dog[2]	2	6.5	183	3	ND	ND	ND	9.2	190	NA
Upper Drenchwater Cr.[3]	5	6.7	56	< 2	3	3.1	< 4	< 0.3	88	12
Upper False Wagner Cr.[3]	3	2.8	2,150	6	48	260	290	10	2,000	1180
Within or downstream of the deposit										
Lik[1]	7	6.2	210	5	< 3	< 10	51	< 10	2,000	127
Red Dog[2]	6	3.5	488	396	< 7*	11*	< 5*	2,100	40,400	NA
Upper Drenchwater Cr.[3]	7	4.2	128	6	6	8	27	5	1,400	32
Upper False Wagner Cr.[3]	2	3.2	979	8	44	120	250	4	2,600	480

Note: ND = no data available. * Data from one site only.

1. Briggs and others (1992); 2. Dames and Moore (1983); 3. Kelley (1997).

3.2.10.3 Groundwater Resources and Quality

Shallow Groundwater Sources

Lakes and rivers deeper than about 6 feet do not generally freeze to the bottom in winter. This creates a layer of unfrozen sediments, or taliks, beneath the permafrost (Sloan 1987). When the sediments are porous materials, such as sand or gravel, an aquifer suitable for pumping groundwater may exist. Shallow groundwater resources are likely in the planning area beneath the Colville River, Teshekpuk Lake, and other deep, large lakes.

Shallow groundwater is also found within permafrost as discontinuous confined waterbodies. The presence of dissolved salts depresses the freezing point of water and allows for local accumulations of saline water within the permafrost. The water is unsuitable for drinking and potentially harmful to vegetation when discharged on the tundra surface (USDOI BLM and Mineral Management Service 2003). The available volumes of this type of shallow groundwater are limited because of the local and restricted nature of the groundwater formation.

Deep Groundwater Sources

Deep wells drilled through the permafrost near Barrow have encountered highly mineralized groundwater at depths of 1,600 to 2,500 feet (Kharaka and Carothers 1988). Temperature logs from 25 wells drilled across the North Slope indicate that the depth to the base of permafrost, and consequently the sub-permafrost water, is generally shallower to the west. Deep wells drilled through the permafrost in the Prudhoe Bay area have encountered highly mineralized groundwater at depths of 3,000 to greater than 5,000 feet (Sloan 1987). Available data suggest that deep groundwater in the NPR-A would probably be similar to that found at Barrow and Prudhoe Bay, and would be too saline for domestic use.

Recharge

Snowmelt provides the major source of water for recharge to the shallow water-bearing zones that occur below large lakes and major streams and to the annual thaw zones that occur beneath ponds and marshy areas (USDOI BLM and MMS 2003). Deeper groundwater zones beneath the permafrost, however, are not as readily recharged. Subpermafrost water may be recharged from areas to the south in the Arctic Foothills and the Brooks Range by infiltration of meltwater.

3.2.10.4 Permafrost

This section includes descriptions of permafrost characteristics which relate to water resources in the NPR-A. A more complete description of permafrost characteristics is in section 3.2.8.2.

Permafrost is defined as soil, sand, gravel, bedrock, or organic material that has remained below 32 °F for 2 or more years in succession (USDA 1999, page 93). Almost continuous throughout the Reserve, permafrost can exist as massive ice wedges and lenses in poorly drained soils or as a relatively dry matrix in well-drained gravel or bedrock.

Permafrost forms a barrier that prevents infiltration of surface water, maintains a saturated layer of surface soils, and restricts groundwater sources to shallow unfrozen material beneath deep lakes and rivers or very deep wells. The limited amount of groundwater on the North Slope is due largely to the presence of permafrost (Williams 1970). Melting ice-rich permafrost can cause surface subsidence, or thermokarst, resulting in thaw lakes, ponds, or beaded stream channels.

Lakes and streams in the Arctic Coastal Plain of the NPR-A influence the characteristics of the upper permafrost surface (USDOI BLM 1978a). Shallow lakes and streams that freeze completely in the winter are directly underlain by permafrost. Deep lakes greater than 7 feet in depth, and major rivers, typically do not freeze to the bottom in winter and are underlain by a thaw depression in the permafrost table.

3.2.10.5 Water Resources and Climate Change

A number of hydrologic shifts related to climate change will affect water resources, including seasonal flow patterns, ice-cover thickness and duration, and the frequency and severity of extreme flood events. Several recent studies have shown that arctic sea ice has been both shrinking and thinning during the past half century. As the sea ice melts, the surface water can absorb more heat from the sun. This results in a positive feedback loop that causes more rapid melting of the sea ice. Based on climate modeling, one study funded by the National Science Foundation and NASA concluded that melting could occur so rapidly that the arctic could become ice free in summer by 2040 (Holland et al. 2006).

The geomorphology (sinuosity, bars, beaches, bends, ox bows, cut banks, pools, riffles, etc.) are determined by the slopes, discharge volumes, frequency, intensity, timing, obstructions, sediment loading, etc., all of which will continue to change over a period of changing climate. The effects of these climatic and hydrologic changes will result in river systems that increasingly move or migrate over the landscape compared to a period of relatively stable climate thus, causing potential disruptions to infrastructure (such as roads and bridges), changes in fish and wildlife habitat, and possible hazards to shoreline communities, fish camps, and recreation users (especially from large shoreline permafrost slumps).

Projected Temperature Changes

Temperatures in the NPR-A are projected to increase over the coming decades at an average rate of about 1 °F per decade from the 1961–1990 historic 30-year average of 40.1 °F (summer) and -9.6 °F (winter). Average annual temperatures are expected to rise by about 3.0 °F (summer) and 10.9 °F (winter) by the 2040s and as much as 5.8 °F (summer) and 18.5 °F (winter) by the 2090s. Mean winter temperatures could reach a high of 8.8 °F by the end of the century, an 18.5 °F increase (Scenarios Network for Alaska Planning 2010).

Projected dates of thaw and freeze, based on average temperatures above or below freezing, were analyzed for the NPR-A and compared to the1961–1990 historic 30-year average. Based on these projections, break-up is expected to arrive approximately 11 days earlier in the Foothills and Brooks Range and about 7 days earlier in the Arctic Coastal Plain by the 2090s. Presently, freeze-up is fairly uniform across the Reserve. Freeze-up is expected to arrive 7 to 10 days later in the Brooks Range and 2 weeks later in the Foothills by the 2090s. The Arctic Coastal Plain may see freeze-up arrive from 2 to 4 weeks later by the 2090s depending on the proximity to the coast with the latest freeze-up occurring along the coastline (Scenarios Network for Alaska Planning 2010).

Projected Precipitation Changes

Annual precipitation is predicted to increase across the NPR-A by 0.5 inches per decade from the 1961 to 1990 historic 30-year average. Average annual precipitation is expected to rise by about 1.1 inches (summer) and 1.6 inches (winter) by the 2040s and as much as 1.5 inches (summer) and 2.7 inches (winter) by the 2090s (Scenarios Network for Alaska Planning 2010).

The term potential evapotranspiration is used to describe the likely amount of water that could be returned to the atmosphere through the combination of evaporation and transpiration. Potential evapotranspiration is determined by the energy available to evaporate water, measured as temperature, and other environmental conditions including wind, cloudiness, plant growth, and humidity. In the NPR-A, potential evapotranspiration during growing season months typically exceeds incoming precipitation, resulting in an overall water deficit (precipitation – potential evapotranspiration) during this time. The

Scenarios Network for Alaska Planning analysis reveals that potential evapotranspiration is expected to remain relatively stable throughout the early century, but water loss due to increased temperature is likely to increase in the later part of the century. Slight increases in precipitation and hydrologic changes driven by potential evapotranspiration may be affected by other climate-related factors such as permafrost thaw and biome shift. Summer water availability (precipitation – potential evapotranspiration) is expected to range from −6.07 inches from the 1961 to 1990 historic 30-year average to −5.29 inches by the 2090s (Scenarios Network for Alaska Planning 2010).

Impacts of Climate Changes

In the NPR-A, 44 percent of the precipitation falls during winter months, when it accumulates in the snowpack and contributes to water storage across the landscape. Some of this wintertime storage is lost due to sublimation, but the majority remains until the spring snowmelt converts it to runoff that serves to recharge rivers, lakes, and soils. In general, the most severe spring floods on cold-regions rivers are associated with a strong climatic gradient between the headwaters and the downstream reaches—typically from south to north on most large arctic rivers (Gray and Prowse 1993). In such cases, the spring flood wave or break-up front produced by snowmelt must "push" downstream into colder conditions, and hence towards a relatively competent ice cover that has experienced little thermal decay. Projected higher-latitude temperature increases will result in a reduction in the strength of this climatic gradient and therefore reduce the severity of break-up and the associated flooding. Warmer temperatures will advance the spring warming period, which means that snowmelt will occur during a period of lower solar radiation, which could lead to a more protracted melt and less intense runoff. Given a scenario of increased temperature and snowfall, effects on the timing of spring melt may be offsetting to some extent—increasing air temperatures facilitate earlier snowmelt, while increasing snow depth retards it.

The effects of early and less intense spring melt will be most dramatic for catchments within the Arctic Coastal Plain, where snowmelt forms the major flow event of the year. Reductions in the spring peak will be accentuated where the loss of permafrost through associated warming increases the capacity to store runoff. Increasing soil storage capacity and more rapid moisture export through evapotranspiration may also lead to decreased hydrologic response to summer storms. Reduced surface storage (e.g., lower lake levels) and drier soils will require greater rainfall recharge before significant surface runoff to streams can occur. As the active layer depth increases and surface storage decreases, the Foothills will have reduced hydrologic responses to storms but greater base flow due to supra-permafrost groundwater flow from soil moisture.

If the surface and near-surface water storage deficit is high due to dry conditions in the previous summer, then a larger volume of snowmelt the following spring will go directly to recharge surface waterbodies and soils and reduce the severity of spring flooding. Overall, the magnitude and frequency of high flows will decline while low flows will increase, thereby flattening the annual hydrograph (Arctic Climate Impact Assessment 2004)

Suspended sediment and nutrient loading of lakes and rivers will increase as thermokarsting, land subsidence, slumping, and landslides increase with permafrost degradation. One small thermokarst gully that formed in 2003 on the Toolik River in a 0.9

square kilometer subcatchment delivered more sediment to the river than is normally delivered in 18 years from 132 square kilometers in the adjacent upper Kuparuk River basin. Ammonium, nitrate, and phosphate concentrations downstream from a thermokarst feature on Imnavait Creek increased significantly compared to upstream reference concentrations and the increased concentrations persisted over the period of sampling (1999–2005) (Bowden et al. 2008).

With expected warming, degrading ice wedges may progressively integrate into drainage channels with a lower base elevation resulting in increased frequency of lake-tapping (sudden drainage) events. Drainage rates of lakes on the North Slope, in cold continuous permafrost, were found to be 1 to 2 lakes per year, but will likely increase in frequency. Where ice-rich soils and a topographic gradient exist (e.g., adjacent to a stream or the coast), sequential lake tapping could occur (McGraw 2008).

The 2007 Intergovernmental Panel on Climate Change best-estimate scenario for the world's oceans projects a sea-level rise in the range of 18 to 38 centimeters by 2100, and likely to be substantially greater than the increase over the last century. With continuing arctic warming and sea ice declines it is expected that sea level will rise and storms with storm surges will be stronger and more frequent and coastal communities now struggling with erosion will see shoreline retreat accelerate (Proshutinsky 2010). The combined effect of sea level rise, increased frequency of storm surges, and increased water temperature has already resulted in a substantial increase in erosion rates on the Beaufort Sea coast (Jorgenson and Brown 2005).

3.2.11 Solid and Hazardous Waste

Existing hazards include solid, human, or hazardous wastes, abandoned structures and vehicles, and abandoned drums. The NPR-A is large and has had limited human or industrial uses that may have introduced hazardous or solid wastes into the environment. Industrial activity has consisted of U.S. Department of Defense (DOD; U.S. Navy, U.S. Air Force, and the Coast Guard) Defense Early Warning Stations (1950s through the 1980s), Long Range or Short Range Radar Sites (1990s to present), antenna; and staging areas, transportation corridors, and research and oil and gas exploration programs conducted by or for the U.S. Navy from the 1940s through the 1970s, and by the U.S. Geological Survey (USGS) from 1977 through 1982 through contractor, Husky. Commercial (private) oil and gas exploration activities began in 1983. Also, commercial winter tundra transport of fuel and goods to North Slope Borough communities has been conducted annually across NPR-A for the past 40 years. Incidental use by the local Alaska Native population for subsistence hunting, fishing, and travel potentially may have created additional wastes on a small scale. For currently identified locations of landfills, formerly used DOD sites, abandoned drum/structures/equipment sites, and legacy wells, see Map 3.2.11-1.

3.2.11.1 Department of Defense Sites

Hazardous materials and wastes, and physical hazards are associated with former Distant Early Warning-Line (DEW-Line) activities in the 1950s through the 1980s. Within the NPR-A, the following former DEW-Line sites have been identified on BLM-managed lands: Icy Cape (LIZ-B), Wainwright (LIZ-3), Peard Bay (LIZ-C), Point Barrow (POW-MAIN), Point Lonely (POW-1), and Kogru (POW-B). (See Table 3-14. For further discussion of

DEW-line sites, see section 4.8.2.2 in Volume 4.) In the 1990s, the Air Force installed short or long-range radar capabilities at the Wainwright, Point Barrow, and Point Lonely sites. The Point Barrow site remains active. The Air Force is in the process of planning to remove structures at Wainwright, Point Barrow, and Point Lonely. Another former DEW-Line site, Cape Simpson (POW-A) is located on an inholding owned by the North Slope Borough within the Planning Area on the Simpson Peninsula. All sites have been characterized and remedial actions under the Comprehensive Environmental Response, Compensation and Liability Act are being planned or conducted; many removal actions have been implemented since the 1970s. Landfills, discussed below, exist at all sites.

Table 3-14. Department of Defense related sites within the planning area

Site code	Site type	Geographical name	Use	Status
LIZ-3	DEW Aux/SRR	Wainwright	NWS Site Established 1994 DEW Operations ceased Apr 1995	Closed 2007. Inlet landfill removed 2010; structures being removed beginning 2011
LIZ-B	DEW "I" Site	Icy Cape	"I" Site Operations ceased 1963	Demolitions and removals completed 1999
LIZ-C	DEW "I" Site	Peard Bay	"I" Site Operations ceased 1963	Demolitions and removals completed 1999
POW-MAIN	DEW Main/NWS LRR	Point Barrow	NWS Site Established 89/90	Some structures removed 2011
POW-A	DEW "I" Site	Cape Simpson	"I" Site Operations ceased 1963; Site owned by North Slope Borough	Demolitions and removals completed 2000
POW-B	DEW "I" Site	Kogru	"I" Site Operations ceased 1963	Demolitions and removals completed 1999
POW-1	DEW Aux NWS SRR	Point Lonely	DEW Operations ceased 1990 Radar Site Established 1994 All Operations ceased 2005	One structure removed 2009
LORAN-C	Loran	Skull Cliff	U.S. Air Force. 1947 – 1953. 625 foot tall tower; Site never functional	Demolition early-1960s to mid 1990s
NARL	NARL	No Luck Lake	NARL Remote Research site ceased 1977	Initial site inventory completed in 2010
NARL	NARL	Brady	Remote Quonset Hut Ceased 1977	Initial site inventory completed in 2010
NARL	NARL	NW Teshekpuk Lake	Remote Research site ceased 1977; USGS use of site since 1977	USGS uses site
Navy	Navy	Driftwood	1950s era eroded gravel bar airstrip and exploration well site; approximately 700 drums and other debris	Initial site inventory completed in 2010; Evidence of use of overgrown Runway in 2010
Navy	Drums	Upper Meade Drum Cache	Approximately 300 drums	Initial inventory conducted in 2010
Navy	Navy	Skull Cliff Test Core Drum Cache	Approximately 200 drums	USACOE initiated investigation in 2010

Naval Arctic Research Laboratory remote sites were established at No Luck Lake, Brady, and on the northwest shoreline of Teshekpuk Lake. The No Luck Lake and Brady sites were abandoned in the late 1970s; the removal of the buildings and numerous abandoned drums and scattered debris is still pending. The Brady site has evidence of winter use by one or more members of the public. The No Luck Lake site includes a broken C-46 fuselage (partially submerged in the lake). The Teshekpuk Lake site cabin has been maintained and is being used by USGS scientists.

Drum caches and staging areas established by Department of Defense agencies for research, exploration, or training have only recently begun to be cataloged within the planning area. Hence, historic sites are still being discovered throughout the planning area such as the Upper Meade River (abandoned drum cache) location confirmed in 2010 along the old Navy tractor trail on Shaningarok Ridge. The drum cache is reported to be in the range of 300 drums (Flora 2010).

3.2.11.2 Legacy Oil and Gas Well Sites

During early exploration programs, the U.S. Navy (1944 to 1953, and 1973 to 1977) and the USGS (1975–1982) drilled 136 wells and core holes termed, "legacy wells" ranging from 100 to 20,335 feet. Some wells were cased and tested and remained test wells. Some were core tests with no casing or wellhead installed. A few were left unplugged and many partially plugged.

Hazardous materials and wastes are associated with areas of abandoned well sites from Navy/USGS drilling or seismic exploration activities in the 1940s through 1982, including camp wastes, empty drums, the drill pad, reserve pit, and flare pit. Five of the legacy sites also had gravel airstrips. A few airstrips remain in use (Inigok, Ivotuk, and Driftwood), although they are not maintained. In some instances, solid wastes were buried at or near legacy well sites.

The BLM initiated a program in 1993 to clean up the 28 drill sites from the USGS exploration period. The BLM prioritized the wells studied in the "Environmental Status of 28 Oil and Gas Exploration Areas of Operation in the National Petroleum Reserve" report for solid waste cleanup based on both the amount of material and potentially hazardous material. This program continued through 1995 and resulted in the removal of 600 pounds of steel from East Teshekpuk, numerous barrels from Ivotuk, and light debris from five other wells. However, the BLM did not have the funding for cleaning up 21 of the 28 well sites. The Navy early-era wells will be scheduled for condition evaluations, pending funding. If Navy wastes, drums, or landfills are identified, the Navy is responsible to address and cleanup the site.

In 2002, the U.S. Army Corp of Engineers conducted an emergency response to plug and abandon Navy Umiat Wells 2 and 5 on the west bank of the Colville River. The river had eroded into the gravel pad surrounding the wells and had exposed solid wastes. The U.S. Army Corp of Engineers removed more than 10,000 cubic yards of spent drilling muds commingled in the gravel pad, preventing a release to the river.

The BLM has assessed the condition of the USGS legacy wells and embarked on a program to plug and abandon those wells that pose a risk. Assessments for the legacy wells can be found in the "Legacy Well Summary Report." Since 2002, the BLM has plugged 18 of 19 wells identified to pose a potential risk to the environment.

3.2.11.3 Landfills and Legacy Well Reserve Pits

The 10 known landfills within the planning area are generally greater than 30-years old (Table 3-15 on page 208). Small, solid-waste landfills have been associated with virtually all of the early drilling sites and at the Camp Lonely staging area. Department of Defense - related landfills exist at Umiat, Kogru, Point Lonely, Peard Bay, Wainwright, Icy Cape; and possibly at No Luck Lake, Brady, and the Teshekpuk Lake NARL cabin. Scattered debris, trash and possibly one or more covered dumps may exist at the former Skull Cliff LORAN site. One cleanup landfill constructed by Husky, consisting of drill steel and scrap metal, is located 0.5 mile west of the Department of Defense West Kogru landfill. This landfill was discovered in 2004; additional landfills associated with the Husky cleanup era may yet be discovered. Most, if not all, of the landfill caps did not sufficiently cover wastes for more than the first two decades following construction. Wind or water erosion, thermokarst activity, or frost-jacking of contents through the cap has occurred exposing wastes buried in the landfills.

In 2006, the Air Force expanded a 1986-era landfill at Point Lonely. In 2008, the same landfill's footprint was more than doubled when the Air Force added contents from a 1950/60s-era landfill (which was eroding into a lagoon of the Beaufort Sea at Point Lonely). Further expansion of the 1986-era landfill was postponed in 2009 due to environmental and climate change concerns. The eroding lagoon landfill removal was completed in 2009. The landfill contents removed in 2009 were placed in the unused hangar for temporary storage along with the demolition debris from the garage pending determination of final disposal of the wastes.

The Air Force is planning to either construct freeze-back landfills at Point Lonely and Wainwright to contain demolition debris with polychlorinated biphenyl (PCB)-amended lead-based paints, petroleum-contaminated gravels, low-level PCB-contaminated gravels, or to haul these wastes to other sites within or outside of the planning area. The U.S. Army Corps of Engineers began planning (2010) for the remediation of the Umiat landfill (constructed in 1973 by the Army), a portion of which may be within NPR-A.

Legacy well reserve pits are regulated by the State of Alaska as a special category of landfill. During the 1975 to 1982 U.S. Navy/USGS exploration period, 28 reserve pits were constructed (Table 3-15). The BLM initiated its first major legacy wells (reserve pits) project with the USGS in 1988–90 to study 28 wells. The final report addressed vegetation re-growth and water quality in the reserve pits. As a result, the Alaska Department of Environmental Conservation provisionally approved closing 27 of the 28 reserve pits. East Teshekpuk #1, due to solid wastes buried under the drill pad, was the only reserve pit at that time that did not meet the standards established (BLM and USGS 1992). Awuna #1 was noted as having surfacial concerns with the reserve pit undermining the existing styrofoam installed to insulate the pad. The East Teshekpuk #1 reserve pit was completely removed in 2007, and periodic foam cleanups have been conducted during the summer seasons at the Awuna #1 site since 1996.

Table 3-15. Known landfills and reserve pits within the planning area

Site type	Geographical name	Significant dates	Responsible party(ies) and status
Landfill (LF06)	Wainwright	1950s era landfill partially submerged in Wainwright Inlet	Air Force. Inlet landfill removal action 2010; scrap metals still remain submerged 100 feet offshore
Landfill (LF05)	Wainwright	Air Force constructed in 1986	Air Force. Asbestos and petroleum stains on surface (Jacobs Engineering 2010)
Landfill	Peard Bay	Landfill on beach near Native Allotments and subsistence cabins	U.S. Army Corp of Engineers. Landfill contents comingled with local dumping; possible second landfill located near road to DEW-Line proper
Debris/trash	Skull Cliff Loran	Debris scattered over large area on tundra/no gravel pads	Navy U.S. Army Corp of Engineers review planned 2011
Landfill	Camp Lonely	Permitted 1976–1989 by USGS, USAF, and others; multiple parties	Site investigation and cleanup in negotiation with Alaska Department of Environmental Conservation and multiple parties including BLM, USGS, USAF, and Navy
Landfill (LF07)	Point Lonely	Lagoon Landfill completely removed by 2009	Air Force. A portion of the landfill contents temporarily stored in hangar pending determination of final disposal
Landfill (LF011)	Point Lonely	Permitted by Alaska Department of Environmental Conservation from 1986–1989; expanded in 2006 and again in 2008	Air Force. Subject to degrading permafrost; possible extreme seawater storm surges
Landfill	Umiat – Colville River	Constructed during mid-1970s cleanup of the Umiat Airfield; land ownership is being determined and includes State of Alaska and possibly NPR-A lands	U.S. Army Corp of Engineers. Partly in Colville River; contaminants of potential concern include PCBs; planning underway for removal/remedial actions
Landfill	Kogru - West	Cell 1 completely removed in 2009; two additional landfill cells inland not yet threatened by erosion	U.S. Army Corp of Engineers. Continued monitoring to track rate of shoreline erosion needed
Landfill	Kogru - Central	Characterized in mid-1990s	U.S. Army Corp of Engineers review 2008; no action planned
Landfill	West Kogru River	USGS/Husky monofill mid-1970s	Continued monitoring to track rate of shoreline erosion needed
Reserve Pit	North Kalikpik	USGS/Husky 1978; cap suffered differential settlement and was partially covered by water by 1989	BLM/USGS. Amended in 2008/9 to temporarily store drilling wastes removed from East Teshekpuk and Atigaru reserve pits
Reserve Pit	Ikpikpuk	USGS/Husky 1980; cap thermokarsted and was covered by up to 4 feet of water by 1984	BLM/USGS. Amended in 2010 to temporarily store drilling wastes removed from Drew Point reserve pits
Reserve Pit	Awuna	USGS/Husky 1981; reserve pit is open, not backfilled; styrofoam exposed in 1989	BLM/USGS. Periodic summer exposed foam cleanups are conducted by BLM

Table 3-15. Known landfills and reserve pits within the planning area

Site type	Geographical name	Significant dates	Responsible party(ies) and status
Reserve Pit	East Simpson #1	USGS/Husky 1979; reserve pit is open, not backfilled	BLM/USGS. Site is being monitored for shoreline erosion
Reserve Pit	East Simpson #2	USGS/Husky 1980; berms around reserve pit disappeared by 1989 due to thermokarst	BLM/USGS. Site is being monitored for shoreline erosion
Reserve Pit	Inigok	USGS/Husky 1979; reserve pit is only partially backfilled.; water depth 4.5 feet in 1984	BLM/USGS. A 5-foot berm surrounding pit is breached on NW and SW sides
Reserve Pit	Koluktak	USGS/Husky 1981; reserve pit is open, not backfilled	BLM/USGS. Pit is 10-feet deep and has breaches on all four sides
Reserve Pit	Kogrua	USGS/Husky 1978; reserve pit is open, not backfilled	BLM/USGS. Pit berm is largely intact; water depth was 5.6 feet in 1984
Reserve Pit	Kuyanuk	USGS/Husky 1981; reserve pit is open, not backfilled; some breaches have formed	BLM/USGS. Site is being monitored for shoreline erosion
Reserve Pit	North Inigok	USGS/Husky 1981; reserve pit is open, not backfilled	BLM/USGS. In 1989, surface water was observed flowing into the pit from the SW
Reserve Pit	Peard	USGS/Husky 1979; reserve pit is open, not backfilled; depth of water was about 7 feet in 1984	BLM/USGS. Thermokarst action has caused perimeter of the pit to become irregular in shape
Reserve Pit	Sea Bee	USGS/Husky 1980; reserve pit is open, not backfilled; water depth was about 4.8 feet in 1984	BLM/USGS. U.S. Army Corps of Engineers backfilled the flarepit in 2006 with thermally treated drilling muds and gravels from Umiat Navy Wells 2 and 5
Reserve Pit	South Harrison	Navy/USGS/Husky 1976–1977; reserve pit differential settlement has left up to 2 feet of water ponded on top of the cap by 1987; breaches exist on three sides of the pit berm	BLM/USGS. Site is being monitored for shoreline erosion
Reserve Pit	South Meade	USGS/Husky 1979; reserve pit differential settlement has left up to 2 feet of water ponded on top of the cap by 1989	BLM/USGS. Oil was reported bubbling to the surface within the reserve pit in 1982; algal growth observed in water in 1983
Reserve Pit	South Simpson	Navy/Husky 1977; the pit was backfilled; berm heights were reduced; subsidence has created multiple breaches; northern berm entirely under water	BLM/Navy. Water in reserve pit was less than 4 feet deep in 1989
Reserve Pit	Tulageak	USGS/Husky 1981; reserve pit is open, not backfilled; water depth was about 4.5 feet in 1984	BLM/USGS. Site is being monitored for shoreline erosion. Berms surrounding pit have subsided and large breaches exist; area is subject to sea storm surges.

Table 3-15. Known landfills and reserve pits within the planning area

Site type	Geographical name	Significant dates	Responsible party(ies) and status
Reserve Pit	Tunalik	USGS/Husky 1980; reserve pit is open, not backfilled; water depth was about 6.5 feet in 1989	BLM/USGS. Thermokarst action has eroded the berms and created breaches and free exchange of water into and out of the pit
Reserve Pit	Walakpa #1	USGS/Husky 1980; reserve pit is open, not backfilled; water depth was about 6 feet in 1984	BLM/USGS. Thermokarst action has eroded the berms and created breaches and free exchange of water into and out of the pit
Reserve Pit	Walakpa #2	USGS/Husky 1981; reserve pit is open, not backfilled; water depth was about 5.5 feet in 1989	BLM/USGS. Breaches occur on three sides of the pit, allowing water to flow into the pit on the west side, and out of the pit on the south and east sides
Reserve Pit	West Dease	USGS/Husky 1980; reserve pit is open, not backfilled; water depth was about 5 feet in 1984	BLM/USGS. Site is being monitored for shoreline erosion; breaches allow water to enter pit from south and exit on the east and west
Reserve Pit	West Fish Creek	Navy/Husky 1977; the pit was backfilled; differential settlement left 60% of cap covered with ponded water by 1989.	BLM/Navy. No breaches observed in pit berms; water might escape during snowmelt or heavy precipitation events

Currently, 21 reserve pits remain under BLM management within the NPR-A. One of the 28 constructed reserve pits (Lisburne) was later determined to be located outside the NPR-A. In 1989, the Cape Halkett site was discovered to be completely underwater and was considered “closed.” The lands including the Atigaru Point and W.T. Foran sites were conveyed to Native corporations; the W.T. Foran reserve pit was removed in the early 1980s for exploration work done for the new landowner, and the Atigaru Point reserve pit was removed by BLM with the landowner’s permission in 2008. Complete removals of the J.W. Dalton, East Teshekpuk, Atigaru, and Drew Point reserve pits occurred from 2005 to 2010, following dramatic coastal erosion near the J.W. Dalton site in 2004. From August to September of 2004, approximately 345 feet of shoreline erosion at the J.W. Dalton site, exposing the exploration well and breaching the reserve pit (Flora 2004). In 2005, the BLM performed an emergency well plugging and abandonment and reserve pit removal from the J.W. Dalton well site. The BLM then initiated a program in the summer of 2005 to monitor infrastructure sites and landfills located within one mile of the Beaufort or Chukchi Seas, or a major lake or river. Since 2005, the East Teshekpuk, Atigaru, and Drew Point wells have been plugged and abandoned and their associated reserve pits removed. The North Kalikpik reserve pit was amended in 2007 and 2008 to temporarily incorporate the drilling wastes from the removed East Teshekpuk and Atigaru reserve pits. Likewise, the Ikpikpuk reserve pit was amended in 2010 to incorporate the drilling wastes from the removed Drew Point reserve pit. The amended sites were constructed to assure that the drilling wastes would remain frozen for the duration of storage—in winter, the frozen wastes were placed 14 to 18 feet below the base of the reserve pit and a minimum of 14 feet of cap placed on top. The amended caps are above the grade of the surrounding berms and sloped for water runoff.

3.2.11.4 Other Uses

Commercial, research, and field-management activities in the planning area have included winter overland transportation trail corridors established during the U.S. Navy exploration era and more recent commercial uses include hunting guide camps authorized by special recreation permits. Campsites and modern era remote fuel caches to support helicopter flying for research and field-management activities have been established within the planning area. Spills of fuel, oil, and other petroleum products may have occurred in the past as a result of these activities. Currently, state law requires all travelers to be responsible for adequate prevention of spills and for prompt notification and cleanup, should a spill occur.

3.2.11.5 Solid and Hazardous Wastes and Climate Change

Climate change impacts, including shoreline erosion and permafrost degradation, have already been documented as seriously affecting landfills or other infrastructure sites within the NPR-A. This was dramatically demonstrated in the coastal and lakeshore erosions that resulted in the clean-up activities at the J.W. Dalton, Atigaru, Drew Point, and East Teshekpuk Lake sites described above. The continued thawing of permafrost could result in land subsidence and much deeper subsurface groundwater active layers. This could result in the failure of historic, existing, or future landfills; thus creating potential for leachate to migrate into nearby waterbodies from landfills. Shoreline erosion could expose sites with subsurface solid or hazardous wastes to the environment, resulting in possible threats to human health, subsistence resources, and the environment.

Climate change will also cause alteration of weather patterns. Storms of higher frequency could be expected in the summer and fall months. Greater sea storm water surges from the Beaufort and Chukchi seas could inundate infrastructure sites, such as landfills, fuel tank farms, or gravel pads containing petroleum contamination causing erosion to expose wastes or contaminants, or resulting in leachate degrading fresh and marine waters. Vegetation could be killed by salt water intrusion, making sites even more susceptible to surface erosion.

3.3 Biological Resources

3.3.1 Vegetation

3.3.1.1 General Description

As stated previously, the NPR-A can be divided into three physiographic provinces occurring roughly as latitudinal bands (Wahrhaftig 1965). From north to south, they are the Arctic Coastal Plain, the Arctic Foothills, and the Arctic Mountains (Brooks Range) provinces (see “Physiography,” section 3.2.4, and Map 3.2.4-1). Most of the described species occur in all three provinces, so the relative frequency of occurrence of each species is a better distinction among provinces (USDOI BLM 2002). Such frequency differences are due primarily to differences in moisture levels. Many lakes and very poorly drained soils dominate the Arctic Coastal Plain, whereas the Brooks Range has few lakes and some well-drained soils. The Arctic Foothills is intermediate in these characteristics (USDOI BLM 2002).

The vegetation of the NPR-A consists primarily of dwarf shrubs, herbaceous plants (especially graminoids), lichens and mosses, which grow close to the ground. Efforts to map the vegetation of Alaska's North Slope occurred as early as 1944 (Spetzman 1959). Early activities used aerial photography and ground reconnaissance, while more recent studies have used digital satellite data.

The studies using digital satellite data concentrated on three areas of the North Slope. In the east, three vegetation-mapping studies (Walker et al. 1982, Markon 1986, Jorgenson et al. 1994) were completed in the Arctic National Wildlife Refuge. The two earlier studies used Landsat Multispectral Scanner (MSS) data, while the more recent study used the next-generation Landsat Thematic Mapper. The highest intensity vegetation studies occurred on the central North Slope near the Prudhoe Bay oil fields. Here, Walker and associates (e.g., Walker and Acevedo 1987, Muller et al. 1998) produced a number of vegetation maps and reports that describe the vegetation of the area and provide techniques showing changes over time resulting from oil field development. Using Landsat MSS data, Morrissey and Ennis (1981) produced a vegetation map for all of the NPR-A west of Prudhoe Bay. A portion of the NPR-A north and east of Teshekpuk Lake was mapped again (Markon and Dirksen 1994); this mapping used data from the French satellite-borne sensor Systeme Pour l'Observation de la Terre (SPOT). The vegetative cover of the NPR-A has been summarized more recently in a map of the entire North Slope (Muller et al. 1999). This map was extrapolated from a map of the Kuparuk River basin (Muller et al. 1998), which used MSS data collected from 1979 to 1986. For a bibliography of the earlier efforts and a more extensive listing of recent studies, see Talbot (1996).

Most recently, the Circumpolar Arctic Vegetation Map Team (2003) worked to standardize techniques and map the entire Arctic region. The Circumpolar Arctic Vegetation Map shows the types of vegetation that occur across the Arctic. The Team grouped over 400 described plant communities into 15 different physiognomic units based on plant growth forms. From this project the Alaska Arctic Tundra Vegetation Map was developed in 2006. However, there is no way to ascribe accuracy to this data as multiple data sources were combined (Raynolds 2007, personal communication).

The classification used in this document was developed for the NPR-A by BLM from 1994 to 1997 in cooperation with Ducks Unlimited, the U.S. Fish and Wildlife Service, and the North Slope Borough. This classification (USDOI BLM 2002) used a more recent generation of satellite data. The primary data source was Landsat Thematic Mapper satellite imagery collected from 1992 to 1995, and secondarily some minor gaps in coverage were filled with SPOT XS data collected in 1994. The thematic mapper data has a ground picture element (pixel) resolution of 30 by 30 meters and measures the spectral reflectance in several frequency bands. With the aid of field-verification and computer analysis, each pixel was classified as 1 of 7 major and 17 minor Earth cover classes. These classes were distinguished from one another based on their relative composition of water coverage, bare ground, and different plant species (Table 3-16). This classification is used here as it has reported accuracies, summarized as 85 percent for the major classes and 75 percent for the minor classes. The 7 major and 17 minor Earth cover classes are described below and shown in Map 3.3.1-1.

1. Water
    a. Clear: Fresh or saline waters with little or no particulate matter. Clear water areas are typically deep (greater than 1 meter). The clear water class generally contains less than 15 percent cover of pendent grass and water sedge.
    b. Turbid: Shallow water (less than 1 meter) or water with particulate matter that typically occurs in shallow lake shelves, deltaic plumes and rivers and lakes with high sediment loads. Turbid water generally contains less than 15 percent cover of pendent grass and water sedge.
    c. Ice: May last into late summer on lakes and larger ponds. Ice is present year round on many larger lakes.
2. Aquatic
    a. Water sedge (*Carex aquatilis*): Associated with lake or pond shorelines and composed of 50 to 80 percent clear or turbid water greater than 10 centimeters deep. The dominant species is water sedge. A small percentage of pendent grass, common mare's tail, marsh fivefinger, or marsh marigold may be present.
    b. Pendent grass (*Arctophila fulva*): Associated with lake or pond shorelines and composed of 50 to 80 percent clear or turbid water greater than 10 centimeters deep. The dominant species is pendent grass. A small percentage of water sedge, common mare's tail, marsh fivefinger, or marsh marigold may be present.
3. Flooded Tundra
    a. Low Centered Polygons: Polygon features that retain water throughout the summer. This class is composed of 25 to 50 percent water. Water sedge is the dominant species in the permanently flooded areas. The drier ridges of the polygons are inhabited mostly by cottongrass species (*Eriophorum*), sphagnum moss (*Sphagnum* spp.), willow (*Salix* spp.), bearberry (*Arctostaphylos alpina* and *A. rubra*), Labrador tea (*Ledum palustre* ssp. *decumbens*) and dwarf birch (*Betula nana* ssp. *exilis*).
    b. Non-patterned: Continuously flooded areas are composed of 25 to 50 percent water. Water sedge is the dominant species. Other species may include common mare's tail (*Hippuris vulgaris*), marsh fivefinger (*Potentilla palustris*), and marsh marigold (*Caltha palustris*). Non-patterned is distinguished by the lack of polygons and associated shrub species.
4. Wet Tundra
    a. Wet Tundra: Associated with areas of super saturated soils and standing water. Wet tundra often floods in early summer and usually drains excess water during dry periods, but remains saturated throughout the summer. It is composed of 10 to 25 percent water. Water sedge is the dominant species. Other species include cottongrass, other sedges, grasses and forbs.
5. Moist Tundra
    a. Sedge/Grass Meadow: This class commonly consists of a continuous mat of sedges and grasses where water sedge is the dominant species. Other dominants include cottongrass, arctic bentgrass (*Agrostis aequivalvis*) and arctic bluegrass

    (*Poa artica*). Other species are Alaska bellheather (*Harrimanella stelleriana*), Labrador tea and blueberry (*Vaccinium uliginosum*).

   b. Tussock tundra: This class is common throughout the foothills and may be found on well-drained soils. It is dominated by cottongrass tussocks (*Eriophorum vaginatum*) with moss as the most common inter-tussock growth form. Lichen, forbs and low shrubs in varying densities are also present.
   c. Moss/ Lichen: Associated with low-lying lakeshores and dry sandy ridges dominated by moss and lichen species. As this type grades into the sedge type, grass-like plants such as water sedge may increase in cover forming an intermediate zone.

6. Shrub
   a. Dwarf: Associated with ridges and well-drained soils and dominated by shrubs less than 1 meter tall. It is the most species diverse class because of the relative dryness of the site. Major species include willow, dwarf birch, Labrador tea, mountain avens (*Geum glaciale*), blueberries, bearberry, tussock cottongrass and water sedge. This class frequently occurs on a substrate of cottongrass tussocks, and is separated from the tussock tundra subclass by having a shrub canopy cover greater than 40 percent.
   b. Low: Associated with small streams and rivers but also occurring on hillsides in the southern portion of NPR-A. This class is dominated by shrubs between 30 centimeters and 1.5 meters. Major species include willow, dwarf birch, alder (*Alnus viridis* ssp. *crispa*) and Labrador tea.
   c. Tall: Found along the Colville River and some of its major tributaries and dominated by willow species greater than 1.5 meters tall. This class may also contain alder greater than 1.5 meters tall.
7. Barren Ground
   a. Dunes/Dry Sand: Associated with streams, rivers, lakes, coastal beaches and dominated by dry sand with less than 10 percent vegetation. Plant species may include bluegrass, willow, sedge, bearberry, and creeping alkali grass (*Puccinellia phryganodes*).
   b. Sparsely Vegetated: Occurs primarily along the coast in areas affected by high or storm tides, in recently drained lake or pond basins and where there is bare mineral soil that is being re-colonized with vegetation. This class is dominated by non-vegetated material with 10 to 30 percent vegetation. The plants in these areas may include rare plants, but some of the more common plants are bluegrass, willow, starwort (*Stellaria* sp.), milk vetch (*Astragalus* sp.), sedge, bearberry and creeping alkali grass.
   c. Other: Associated with river and stream gravel bars, mountainous areas and urban areas. Encompasses all areas with less than 10 percent vegetation other than areas of "dunes/dry sand." May include dead vegetation associated with salt burn from ocean water.

Table 3-16 shows that 9.4 percent of the NPR-A is open water, while another 12.3 percent (Aquatic, Flooded and Wet classes) has standing water with varying proportions of plant cover. The great majority of these wet cover types is in the northern portion of the NPR-A (USDOI BLM 2002). Overall, the single most common cover type is dwarf shrub, with tussock cottongrass being the second most common. The tussock cottongrass form is an important caribou forage species (section 3.3.6.1, "Caribou") and is more prevalent than it first appears from the table, because the Dwarf Shrub class commonly includes cottongrass tussocks as well. The distinction between the Tussock Tundra and Dwarf Shrub classes is based on the relative proportion of shrubs, a dominant life form, in the canopy layer. Combining these two classes suggests a total cover by tussocks in the NPR-A of up to 65 percent.

Table 3-16. National Petroleum Reserve-Alaska Earth cover classification

Earth cover class/subclass	Characteristics of Earth cover class/subclass	Percent of planning area covered By class/subclass
Water	>80% water	**9.4**
Ice	≥60% ice	0.6
Clear water	Depth >3.3 feet (1 meter) and no turbidity	5.0
Turbid water	Depth ≤3.3 feet (1 meter) or turbid	3.8
Aquatic	>50% but <80% water and >4 inches (10 cm) deep	**1.9**
Water sedge	>15% water sedge	1.6
Pendent grass	>15% pendent grass	0.3
Flooded Tundra	>25% but <50% water and <4 inches (10 cm) deep	**6.0**
Low centered polygons	≥5% sedge/grass	3.7
Non-patterned	<5% sedge/grass	2.3
Wet Tundra	>10% but <25% water	**4.4**
Moist Tundra	<10% water, <40% shrub (mostly sedges, grasses, rushes, and moss/peat/lichen)	31.2
Sedge/grass meadow	≥50% sedge/grass and <40% tussock cottongrass	5.2
Tussock tundra	≥40% tussock cottongrass	25.0
Moss/lichen	≥50% moss and/or lichen	1.0
Shrub	<5% water and >40% shrub	**44.1**
Dwarf	≤12 inches (30 cm) in height	40.4
Low	>12 inches (30 cm) but <4.9 feet (1.5 meters) in height	3.7
Tall	≥4.9 feet (1.5 meters) in height	0.01
Barren Ground	0-30% vegetation	**2.7**
Sparsely vegetated	10-30% vegetated	1.3
Dunes/dry sand	<10% vegetation and <10% wet sand, mud, or rock	0.3
Other	<10% vegetation and ≥10% wet sand, mud, or rock	1.1

Key: ≥ - less than or equal to; > - less than; ≤ - greater than or equal to; and < - greater than.
Source: USDOI BLM 2002

Table 3-16 indicates that the moist tundra, moss/lichen class is fairly rare (1.0 percent total cover; about 217,000 acres) in the NPR-A. Lichens are selected by foraging caribou during the calving season in a higher proportion than they exist among plant species on the ground (Kelleyhouse 2001) and are considered to dominate the winter diet of caribou (Klein 1992). The rarity of the moss/lichen class appears in conflict with the known importance of much of the NPR-A to caribou (see "Caribou," section 3.3.6.1). Importantly, though, lichens occur as a minor component in most of the other Earth cover classes. Among those, the highest lichen occurrence (43 to 47 grams per square meter) is in the dwarf shrub class (Kuropat 1984) which makes up 40 percent of the NPR-A as a whole, and a much higher percentage of the southern portion of the NPR-A (USDOI BLM 2002).

3.3.1.2 BLM Sensitive Plant Species

BLM sensitive species are a subset of the BLM special status species category and are designated by the BLM State Director for Alaska. Nine BLM sensitive species of plants are known to occur (Cortés-Burns et al. 2009) within the exterior boundaries of NPR-A: alpine Whitlow-grass (*Draba micropetala*), Adam's Whitlow-grass (*Draba pauciflora*), oriental Junegrass (*Koeleria asiatica*), Drummond's bluebell (*Mertensia drummondii*), arctic poppy (*Papaver gorodkovii*), Sabine grass (*Pleuropogon sabinei*), Alaskan bluegrass (*Poa hartzii* ssp. *alaskana*), circumpolar cinquefoil (*Potentilla stipularis*), and grassleaf sorrel (*Rumex graminifolius*). Summaries of what is known of these plants in NPR-A can be found in the discussion of "Special Status Species" in section 3.3.8.1

3.3.1.3 Non-native and Invasive Plant Species

Little is known about non-native, invasive plant species in the NPR-A. The Alaska Exotic Plants Information Clearinghouse database[9] includes no survey data for the area north of the Brooks Range crest other than one survey along the Dalton Highway. Beginning at the Yukon River, that Dalton Highway survey detected 28 species of non-native, invasive plants. Two of those, foxtail barley (*Hordeum jubatum*) and common dandelion (*Taraxacum officinale*), were found north of the Brooks Range crest. South of the Brooks Range and off the Dalton Highway, surveys at Arctic Village in 2009 resulted in detection of 10 non-native, invasive plants, indicating the potential for non-native, invasive plants to occur in remote areas of northern Alaska. Also, surveys conducted in 2002 along the upper Noatak River, Walker Lake, and Arrigetch Creek within the Gates of the Arctic National Park and Preserve detected one non-native, invasive species at 1 of 73 sites (common dandelion). Anecdotal observation of common dandelion in the NPR-A has been reported, but not verified.

Highways such as the Dalton, and rivers and trails provide corridors for movement of non-native, invasive plants to uninfected areas. Many mechanisms may act as vectors for spread of non-native, invasive plants from these corridors, including equipment and vehicles used for exploration and construction. Aircraft may also act as vectors of spread from airstrips and ponds contaminated by weeds. A search of the Alaska Exotic Plants Information Clearinghouse for data on airstrips documents the occurrence of yellow sweetclover (*Melilotus officinalis*) and bird vetch (*Vicia cracca*), among other highly invasive weeds, at village and other strips north of the Alaska Range, but south of the Brooks Range.

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[9] http://akweeds.uaa.alaska.edu/

3.3.1.4 Vegetation and Climate Change

Temperatures in Alaska, and throughout the Arctic, are thought to have fluctuated considerably over the last few centuries (Mann et al. 1999). Despite this fluctuation, the last 100 years appear to have been the warmest century in the last 400 years (Overpeck et al. 1997, Intergovernmental Panel on Climate Change 2001, Arctic Climate Impact Assessment 2004). Alaska's surface air temperature has warmed throughout much of the state since at least the mid-1970s (Intergovernmental Panel on Climate Change 2001, Arctic Climate Impact Assessment 2004). Continued warming of the climate could have major effects on the ecosystems of Alaska, particularly the North Slope.

The climate change scenario presented here (Scenario Network for Alaska Planning 2011) for the rest of this century suggests that climate will get warmer, with greater precipitation, but that longer, warmer summers will increase evapotranspiration so that there will actually be less moisture available to plants. Summer temperatures may increase about 3 °F over the NPR-A as a whole in the next 30 to 40 years, and about 6 °F in the next 80 to 90 years. Winter temperatures are expected to increase much more, about 11 °F and 18 °F by the 2040s and 2090s, respectively. Summer precipitation may increase by about 1 inch by the 2040s and another half-inch by the 2090s. These may not sound like significant increases, but in fact represent 19 percent and 26 percent increases, respectively, over the current averages. Winter precipitation is expected to increase even more than summer precipitation: by 1.6 inches and 2.7 inches for the two time periods. These are increases of 35 percent and 58 percent, respectively.

Increases in winter precipitation may have little impact on available soil moisture during the growing season, as most snowmelt runs off the land immediately during the spring thaw. What soaks into the minimally thawed soils during break-up may already be at or near maximum so increased snow melt would not have an additive effect. In summer, some precipitation will be lost through evaporation and some through transpiration by plants. In longer, warmer summers, both of these amounts would increase. However, due to the increase in summer precipitation, available soil moisture is predicted to be fairly stable throughout the century (Scenario Network for Alaska Planning 2011).

Chapin et al. (1995) suggested that climate change might already be altering the species composition of the Alaskan Arctic tundra. A warmer environment with a longer growing season could greatly affect the productivity and growth form composition of tundra by causing a more rapid release of nutrients from decomposing soil organic matter (Nadelhoffer et al. 1991). Similarly, changes in the water table, which alter decomposition and nutrient availability, may substantially alter the carbon balance of tundra and taiga microcosms (Billings et al. 1983, Funk et al. 1994). These changes may eventually lead to shifts in the composition of Arctic tundra toward increased shrub height and cover extent (Chapin et al. 1995, Sturm et al. 2001, Walker et al. 2006) as suggested below by Scenario Network for Alaska Planning (2011) and increased grass and sedge (including cottongrass) species in some areas. These increases would likely be at the expense of lichen and moss cover (Chapin et al. 1995, Cornelissen et al. 2001, Jorgenson and Buchholtz 2003, Epstein et al. 2004, Walker et al. 2006). Anderson and Weller (1996) predicted a decline in the abundance of grasses and sedges. The apparent disagreement regarding sedges may be a question of relative abundance versus net primary productivity. Net primary productivity is predicted to increase in both shrubs (especially birch) and sedges (Euskirchen 2009), but percent canopy cover of birches may increase at the expense of canopy cover of sedges. These changes have already been observed to some extent on the North Slope.

Warmer soil temperatures are likely to increase thermokarst, and increases in sea level may inundate low-lying tundra areas, increasing salt marsh, aquatic and wet tundra vegetation types and erosion of coastal bluffs (Arctic Climate Impact Assessment 2004). Such impacts of climate change could accelerate or exacerbate changes in soil thermal regimes that occur with development, potentially leading to greater impacts to vegetation from changes associated with thermokarst.

Alaska's North Slope experienced its largest wildfire (256,000 acres) in history during the summer of 2007 in an area about 25 miles east of the NPR-A (Racine and Jandt 2008). It is not clear at this time if it was a result of climate change. Not only was this fire unprecedented in size relative to past North Slope fires, but it was also unusual in that the majority of the acres burned in September and the fire crossed both coastal plain and foothills ecosystems. The entire North Slope was unusually dry in the summer of 2007, and the question not yet answered is whether this was a first look at a new, long-term trend in weather, due to climate change, or a one-time phenomenon. The model used here (Scenario Network for Alaska Planning 2011) suggests there will be more summer precipitation but that evapotranspiration will also increase. Some have already predicted that climate warming will lead to more wildfires in the arctic tundra, as well as the boreal forest (Wein 1976, McCoy and Burn 2005). Study of tundra vegetation recovery following a fire near the western boundary of the NPR-A (Racine et al. 1987) showed that total vascular plant cover returned to pre-fire levels in 6 to 10 years, but depending on burn severity the species composition may be altered, at least at first. Lichens and some mosses may take several decades to recover. Indeed, a more recent review (Joly and Jandt 2007) that integrates effects of wildfire, climate warming, and caribou grazing suggests that a decline of lichen in tussock tundra may accelerate and the lichen community may potentially disappear.

The overall result of climate change on vegetation appears to be that growing season will be longer, and soils will be warmer and actually drier. Active layer depth (depth of thawed soil during summer) may increase 33 percent on average across the NPR-A from the present to the 2090s (roughly from 0.5 to 0.7 meters). These differences have the potential to drive significant changes in plant communities of the NPR-A. The Scenario Network for Alaska Planning (2011) biome model classifies the NPR-A currently as "arctic," characterized by cold and dry conditions and nearly continuous permafrost, and dominated by tundra and low shrub plant communities. This model suggests, however, that by the 2090s the NPR-A will contain significant acreages of "boreal cordillera," with permafrost likely only at higher elevations and vegetative cover ranging from open to closed forest canopies; "western tundra," which is similar to the "arctic" biome but with a moist, sub-polar climate, patches of stunted trees, and a greater presence of tall shrub communities; and "boreal transition" with boreal forests in valleys and lowlands, and scattered pockets of permafrost.

3.3.2 Wetlands and Floodplains

3.3.2.1 Wetland and Floodplain Definitions

The definition of the term "wetland" varies. Through the National Wetlands Inventory program, the U.S. Fish and Wildlife Service uses ecological characteristics to define wetlands (Cowardin et al. 1979). According to this protocol, the essential attributes of wetlands are the presence of wetland plants (hydrophytes), the presence of wet soils (hydric soils), or soil saturation or flooding. The National Wetlands Inventory program has completed classification of most of the NPR-A north of 70 degrees latitude, identifying virtually all of it as wetlands[10].

The U.S. Army Corp of Engineers and the EPA (*Federal Register*, July 19, 1977) jointly defined wetlands as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (22 CFR 328.3). The Corp technical guideline for wetlands includes most, but not all, wetlands identified in the U.S. Fish and Wildlife Service system. The U.S. Fish and Wildlife Service system requires that a positive indicator of wetlands be present for any one of the three parameters, (vegetation, soils, and hydrology), while the U.S. Army Corp of Engineers technical guideline for wetlands requires that a positive wetland indicator be present for each parameter, except in limited instances identified in the manual. (U.S. Army Corp of Engineers 1987)

The general definition of a floodplain is the lowland and relatively flat area adjoining inland and coastal waters, including at a minimum that area subject to a 1 percent or greater chance of flooding in any given year (also referred to as the 100-year or base floodplain) (Executive Order 11988).

3.3.2.2 Distribution of Wetlands and Floodplains

With the exception of thaw bulbs under larger lakes and streams, permafrost is continuous under the NPR-A. Since permafrost forms an impenetrable barrier to water percolation, the soils of the active layer above it remain saturated during summer in all but a few cases. Even "moist tundra" over these saturated soils would be classified as wetlands (BLM and Ducks Unlimited 2002). Because of the high shrub component, the Dwarf and Low Shrub subclasses are separated from the Moist Tundra class (see Table 3-16 on page 215). The Dwarf and Low Shrub subclasses also exist on saturated tundra (Kempka et al. 1995, Pacific Meridian Resources 1996) and much of the Dwarf Shrub subclass exists on areas of sedge tussocks. Only the Tall Shrubs subclass, certain areas of lichen-covered rocks or bare rocks or sand may not qualify as wetlands; however, the remainder of the NPR-A would qualify as wetlands. This indicates that more than 95 percent of the Reserve would be classified as wetlands by at least one of the two sets of criteria.

The land cover classification for NPR-A in Table 3-16 provides a first order approximation of the amount of the Reserve that would classify as wetlands. The classification scheme for the land cover inventory was developed through a series of meetings with biologists familiar with the vegetation and from previous work, (Markon and Derkson 1994). The classification scheme consisted of seven major categories and seventeen subcategories using Landsat Thematic Mapper satellite scenes to classify the project area into Earth cover categories and ground checked.

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[10] http://www.fws.gov/wetlands/Data/Mapper.html

Many of the floodplains in the Arctic Coastal Plains are very wide because of the low topographic relief. Water surface elevations within the lower floodplains are also typically elevated due to snow and ice in the channel during breakup, often in combination with the presence of bottom-fast sea ice, which can back up water upstream. Late-summer storm surges can also produce flooding in late summer. The floodplain map developed for lower Fish Creek predicts a five-mile wide area of inundation during a 100-year flood event (URS Corporation 2002). The Colville River floodplain delineates the eastern boundary of the NPR-A. Other river systems with extensive floodplains include the Meade, Topogorak, Chipp, and Ikpikpuk rivers.

3.3.2.3 Functions and Values of Wetlands and Floodplains

Arctic wetlands provide many useful functions. The various ponds, lakes, and drainages of the Arctic Coastal Plain regulate runoff through storage in the active layer, slowly releasing water to streams over extended periods. Arctic wetlands generally are not sites of discharge or recharge for subpermafrost aquifers, but supra-permafrost groundwater can influence wetland communities beneath Arctic slopes in ways comparable to aquifer discharge in temperate regions (Post 1990).

Arctic wetlands retain or distribute sediments, nutrients, and toxicants. At breakup, streams flood adjacent tundra creating extensive wetland complexes that provide sites for suspended solids to settle, and sediment is trapped by riparian wetlands along large Arctic rivers with mountain headwaters. Microbes and plants contribute to nutrient and contaminant retention or transformation in tundra wetlands since Arctic-tundra species are adapted to low temperatures and are biologically active even under harsh conditions (Post 1990).

Net primary production, nutrient export, and food-chain support are important functions of Arctic wetlands. Tundra production is remarkably high—approximately one-half that of temperate grasslands—and supplies the energy (plant biomass) on which animals exist. Nutrient export is an important function of Arctic wetlands. Arctic-tundra wetland supports food chains, both through the herbivore-based trophic system (from living plant tissues to rodents and ungulates and their predators) and through the detritus-based trophic system (from dead plant tissue to invertebrate to shorebirds and their predators) (Post 1990). Alaska's Arctic Coastal Plain is largely wetland and supports both herbivore-based and detritus-based trophic systems (Batzli et al. 1980, Hobbie 1984). Waterfowl, lemming, and caribou are major primary consumers on the Arctic Coastal Plain, with the muskox playing an important role elsewhere on Arctic ranges (White et al. 1981).

Floodplains also provide many essential functions. Floodplains provide temporary storage space for floodwaters and sediment produced by the watershed. Flood peaks are reduced by this storage. In most cases, once a flood reaches the floodplain, large increases in discharge can be accommodated with very little water surface elevation change. Once streams overflow their banks, sediment-laden water spreads out over the floodplain, loses velocity, and sediments are deposited. These sediments and associated nutrients enhance soils and create growing conditions for healthy riparian areas that can support a multitude of wildlife. Besides providing temporary storage space for floodwaters and sediment produced by the watershed, floodplains can function as "movement corridors" for large animals including caribou and bear (Walker et al. 1987).

3.3.2.4 Wetlands and Floodplains and Climate Change

The potential for many shallow streams, ponds, and wetlands in the Arctic to dry out under a warming climate is increased by the loss of permafrost. These shallow systems depend on snowmelt as their primary source of water, with rainfall gains often negated by evapotranspiration during the summer. Evaporation from these shallow waterbodies is very likely to increase as the ice-free season lengthens. Hence, the water budget of most lake, pond, and wetland systems is likely to depend more heavily on the supply of spring meltwater from winter precipitation to produce a positive annual water balance, and these systems are more likely to dry out during the summer (Arctic Climate Impact Assessment 2004). The permafrost active layer within the coastal plain may increase by 3 centimeters by the 2040s and 13 centimeters by the end of the century (Scenario Network for Alaska Planning 2010). In other areas, warming of the surface permafrost could increase the formation of ponds, wetlands, and drainage networks, especially in areas with heavy concentrations of ground ice. Such thawing could also lead to large increases in sediment being deposited in rivers, lakes, and coastal marine environments, potentially impacting aquatic organisms.

Climate change could alter species composition, increasing the prevalence of deciduous shrubs and decreasing the prevalence of wetland sedges and grasses, and could greatly influence wetlands through hydrological changes. Chapin et al. (1995) suggested that climate change might be altering the species composition of the Alaskan Arctic tundra. Climate changes may eventually lead to shifts in the composition of Arctic tundra toward more shrub species at the expense of grass and sedge species. Warmer soil temperatures are likely to increase thermokarst and increases in sea level may inundate low-lying tundra areas increasing aquatic and wet tundra vegetation types and increase erosion of coastal bluffs (Arctic Climate Impact Assessment 2004). Such impacts of climate change could accelerate or exacerbate changes in soil thermal regimes that occur with oil and gas development potentially leading to greater and/or cumulative impacts (Walker et al. 1987) to wetlands from changes associated with thermokarst.

A number of hydrologic shifts related to climate change will affect lakes, rivers and floodplains, including seasonal flow patterns, ice-cover thickness and duration, and the frequency and severity of extreme flood events. The greatest ice-related ecological impacts of climate change on arctic river systems are likely to result from changes in breakup timing and intensity (Arctic Climate Impact Assessment 2004). As well as favoring earlier breakup, higher spring air temperatures can affect breakup severity (Prowse and Beltaos 2002). For regions that experience a more "thermal" or less dynamic ice breakup (Gray and Prowse 1993), the magnitude of the annual spring flood will very probably be reduced. For the many northern communities that historically located near river floodplains for ease of transportation access, reductions in spring ice-jam flooding would be a benefit. In contrast, however, reductions in the frequency and severity of ice-jam flooding would have a serious impact on river ecology since the physical disturbances associated with breakup scouring and flooding are very important to nutrient and organic matter dynamics, spring water chemistry, and the abundance and diversity of river biota (Cunjak et al. 1998, Prowse and Culp 2003, Scrimgeour et al. 1994)

3.3.3 Wildland Fire

Wildland fires include both wildfires and prescribed fires. Wildfires are unplanned fires that occur in wildlands and are caused by human or natural means (e.g., lightning strikes), whereas prescribed fires are naturally or manually ignited fires that occur in areas where burning is planned. Prescribed fires have not been used as a management tool within the planning area for vegetation management purposes and are not proposed (USDOI BLM and MMS 2003).

Large wildfires are rare in the tundra; most are small. Median fire size is about 80 acres. Although fires larger than 10,000 acres have occurred, the 256,000-acre Anaktuvuk River Fire in 2007 was unprecedented. Palynological investigation of two foothills lakes shows little evidence of large, extensive fires in the last 5,000 years (Hu et al. 2010). Subsequent analysis of deeper lake cores have revealed only a few large fires in the last 9,000 years or so.

Lightning is the predominant cause of wildland fires, although some human ignitions occur. Tundra fires can appear as early as May, but most ignitions are coincident with lightning, which peaks in June and July. Fires in the northern portions of Alaska, such as the NPR-A, are commonly stopped by discontinuities in vegetation, wet areas, or physical obstructions (Wein 1976).

Fire behavior on the tundra tends to be of low to moderate intensity, with low to moderate rates of spread and flame length. The severity of burns depends on the amount of moisture in the organic soil layers. Small fires are characterized by consumption of no more than the fine surface fuels while larger fires burn to varying degrees into the duff. At the severe 2007 Anaktuvuk River Fire, duff consumption in moist acidic tundra averaged about 31 percent by weight and 30 percent by depth, representing less than 50 years of accumulation (Mack et al. 2011).

Succession following fire is fairly rapid for herbaceous species. Tussock grasses, sedges, grasses, and some herbs recover to pre-fire abundance within several years. Some shrubs recover slowly, on the order of decades while others disappear. Sphagnum mosses decline following fire. Lichens take a long time to reestablish and grow, on the order of 50 years or more (Jandt et al. 2008). Lichen is the main winter forage of caribou. While some fire may be necessary to invigorate lichen production, a situation where the fire rotation exceeds the lichen recovery period may adversely affect caribou populations and, by extension, subsistence cultures that hunt them.

Smoke from wildland fires will be managed using the procedures laid out in "Smoke Effects Mitigation and Public Health Protection Procedures 2007." The smoke management procedures can be found on the Alaska Interagency coordination Center's website.[11] Several other documents and links about smoke and wildland fire management can also be found at the website.

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[11] http://fire.ak.blm.gov/administration/awfcg.php

3.3.3.1 Fire Regime and Condition Class

A fire regime and condition class (FRCC) analysis will not be completed for this plan. The last 10 years there have been nine fires for a total of 315 acres burned in the planning area. An FRCC analysis is not warranted (FRCC Guidebook [Barrett et al. 2010][12]).

3.3.3.2 Fire and Climate Change

The number of recorded fires on the North Slope has increased in the last 40 years. This apparent increase in fire frequency may be explained by apathetic record keeping in decades past and/or by modern improvements in detection. Since it was historically believed that arctic tundra fires were inconsequential, many reports were politely accepted but went undocumented. The cost of reconnaissance flights and transportation of equipment and people to fires would have been prohibitive given that fires would most likely naturally extinguish.

At the same time that the number of recorded fires has increased, there has been a decrease in the size of the fires detected, which suggests that even the small fires are currently found by aircraft or by modern remote sensing technology such as MODIS. Detections have no doubt steadily increased since the period of oil exploration in the 1970s. While fire frequency is probably increasing, the true magnitude of the trend remains speculative.

Only in the last few years has the BLM kept reliable information on lightening detection in the Arctic making predicting effects of climate change difficult. SNAP has predicted virtually no increase in the likelihood of fire in the next ninety years, though by the end of the century fire may increase due to climate change, most likely in the upper Colville River drainage (Scenario Network for Alaska Planning 2010).

3.3.4 Fish

This section includes descriptions of fish habitats and fish species in the NPR-A. Additional information on the physical and chemical characteristics of rivers and lakes is in section 3.2.10, "Water Resources," and 3.3.2, "Wetlands and Floodplains." Details on subsistence fisheries in the region of the NPR-A are described in section 3.4.3, "Subsistence." Sport fishing in the NPR-A is addressed in section 3.4.6, "Recreation."

3.3.4.1 Fish Habitat

The majority of aquatic habitat in the NPR-A exhibits minimal or no impacts as a result of anthropogenic activities. Many of the more important attributes influencing fish habitat, such as streambanks and channels, lakeshores, substrates, water quality and quantity, floodplains, and riparian areas are largely unaltered from their natural condition.

The location, size, and morphology of rivers and lakes, and the natural balance of physical and chemical attributes, control the diversity and distribution of fish. Rivers in the NPR-A flow through three physiographic regions designated as the Arctic Mountains, Arctic Foothills, and Arctic Coastal Plain provinces (Warhaftig 1965; Map 3.2.4-1). Across these regions gradients range from steep mountain headwaters in the Arctic Mountains to extremely flat plains with poorly developed drainage networks in the Arctic Coastal Plain. Proportionately, the amount of stream and river habitat with upland morphology and gravel-dominated substrate is low. Sand- and silt-dominated substrate is prevalent in a greater part of the NPR-A. Fine substrates and a shallow active layer in the Arctic Coastal Plain contribute to widespread channel instability in many systems and historical channel migrations are evident from the large number of oxbow lakes. The location of river mouths can also influence fish use of inland watersheds in terms of accessibility and the type and extent of coastal habitat. Roughly three-quarters of the NPR-A drains into the western Beaufort Sea, with the remaining area draining into the northeast Chukchi Sea (Map 3.2.4-1).

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[12] http://www.frcc.gov

There are thousands of lakes in the NPR-A, ranging from shallow potholes to deep expansive waterbodies (Map 3.2.10-1). Most of these are characterized by fine substrate except for some that are in an upland topographic setting. Annual flow regimes in streams and rivers throughout the NPR-A influence the amount of lake habitat that is accessible to fish. The degree to which a lake is connected or in close proximity to channel habitat determines the extent to which it is available for fish use, and this is highly influenced by annual flow regimes in streams and rivers. Lake connections vary greatly and can change throughout the open-water season, with some only occurring during high flows in the spring. Other lakes consistently remain accessible by fish. High flows during spring breakup also flood some lakes with no discernible connecting channel, with lakes in close proximity to streams and rivers flooding most frequently. These lakes show a gradation of use depending on how frequently a lake is inundated by spring flooding. Lakes flooded annually can be occupied by almost any species found in the adjacent river system while infrequently flooded lakes typically have less diverse fish communities (MJM Research 1998, 2001a, 2003a). For example, many of the shallow, unconnected lakes in the Arctic are either fishless or only contain resilient ninespine stickleback (Hablett 1979, Craig and Schmidt 1982, MJM Research 1998, 2005a). Moulton (MJM Research 1998) developed a widely applicable lake-type classification for the Arctic based on the potential for access by fish:

- Drainage lakes: these are part of a well-defined drainage system with a year-round, active connection to a river or stream, and do not drain as water levels recede.
- Tapped lakes: like drainage lakes, these have an active connection to a river or stream during the summer while water levels remain high enough. However, they drain as water levels recede and the connection can be intermittent.
- Perched lakes: these lakes often lack well-defined connections to river or stream channels. They are flooded under high water conditions, but do not drain like tapped lakes when floodwaters recede, because the connection is severed at that time.
- Tundra lakes: these are not connected to a river drainage nor typically flooded by rivers and are typically thaw-lakes.

Fish species found in the NPR-A have diverse life history patterns and habitat requirements. However, habitat components common to all species are those necessary to accomplish feeding, spawning, and overwintering. For many Arctic fish, seasonal migration corridors are also a vital habitat component.

The 3- to 4-month-Arctic summer is the critical time for fish to find quality feeding habitat, as food is plentiful only during this period (Craig 1989a). Food sources for different species are highly variable, but primarily include terrestrial and aquatic invertebrates and their larvae, zooplankton, smaller fish, or fish eggs (Bendock and Burr 1984, Craig 1984a and 1989a, Moulton et al. 2007 and 2010, Bond and Erickson 1985). Arctic freshwaters are typically low in productivity (Hobbie 1984, Harvey et al. 1998, Moulton et al. 2010) and many of the main river channels are much less productive than small tributaries or connected lakes that are usually warmer. As a result, these peripheral habitats may be more highly utilized for feeding (Morris 2003, Moulton 2005, Moulton et al. 2007). Particularly early in the summer, shallow lakes that thaw early and are accessible to fish likely provide valuable feeding habitat. However, in late June through July many shallow lakes can reach too high of a temperature for some species (Moulton 2005), leading them to seek out other more suitable feeding areas in channel habitats or deeper lakes. Additionally, runoff from the largest rivers mixes with coastal water to create warm, brackish conditions in nearshore areas, particularly near the river mouths (Craig 1984a). Marine invertebrates migrate into this productive nearshore band of water and freshwater invertebrates are flushed downstream into the nearshore zone. Many fish move from freshwater habitats to this estuarine zone to take advantage of the increased food supply. Some species are limited to feeding in low-salinity waters, while others have the osmoregulatory capabilities to regulate salt balance and can feed up to several miles offshore (Gallaway 1990). It is during this summer feeding period that Arctic fish achieve most of their yearly growth (Fechhelm et al. 1992, Griffiths et al. 1992) and accumulate fat and protein reserves needed to survive the winter (Fechhelm et al. 1995, 1996).

Spawning habitat requirements vary for different Arctic fish species and can occur in a wide range of lotic (flowing) or lentic (still) waters. Some species can spawn successfully in areas of silt or sand substrate, while many others require gravel of a particular size class and relatively clear water (Morrow 1980, Bjornn and Reiser 1991, Mecklenburg 2002). Therefore, ideal spawning habitat for one species in part of a river or lake may be unsuitable for other species, making it impractical to define spawning habitat in general terms. However, regarding the availability of spawning habitat types, it is important to note that gravel is relatively uncommon in much of the NPR-A. Furthermore, many of the areas having gravel substrate are in the upper reaches of rivers and freeze completely in winter, limiting the ability for fertilized eggs to survive the winter. As a result, viable gravel spawning habitat is significantly limited. Because of the different spawning needs for fish, identification of spawning areas must occur for individual species and current knowledge of such locations in the NPR-A is substantially lacking. Seasonal time periods for most fish spawning in the Arctic are known (USDOI BLM 1978, Bendock 1979a, Gusey 1982, 1988). Except for burbot, which spawn under ice in late winter, Arctic freshwater fish spawn between breakup (late May or June) and late fall (October).

Overwintering habitat is a major factor constraining fish populations in the Arctic (Schmidt et al. 1989, Gallaway 1990). During the 8- to-9-month winter period, ice formation reduces stream habitat by up to 95 percent, portions of the low salinity near-shore coastal habitat freeze, and unfrozen coastal waters are supercooled (i.e., less than 0 °C) (Craig 1989a). Fish migrate to limited deepwater sites in lakes, rivers, and coastal areas during the winter to survive. Because waterbodies typically freeze to about 5 to 6 feet in depth during winter (Baker 2002, Hinzman et al. 2006, Hilton et al. 2009), water depths of approximately 7 feet are considered the minimum for supporting overwintering freshwater fish. However, some lakes shallower than 7 feet that do not freeze entirely to the bottom provide limited overwintering habitat for some fish that can tolerate more extreme conditions. Overwintering waters must also be of sufficient size to sustain fish oxygen demands for several months (Cott et al. 2008), depending on the number and species of fish utilizing an area. Oxygen depletion, caused by overcrowding or over-demand by biological and chemical processes, can result in fish mortality (Schreier et al. 1980 and 1989, Reynolds 1997) as well as non-lethal effects (Kramer 1987, Evans 2007). However, some species are able to endure lower dissolved oxygen concentrations than others and survive the winter in more marginal conditions (Reynolds 1997, Cott et al. 2008). All of the lakes greater than approximately 13 feet (4 meters) in depth shown on Map 3.2.10-1 provide substantial overwintering habitat. Many of the lakes ranging between approximately 5 and 13 feet (1.6 and 4 meters) in depth also likely provide overwintering habitat, although lakes on the shallower end of the spectrum in that category may freeze to the bottom or only provide habitat characterized by very marginal conditions. Much less is known about the actual distribution and extent of deep channel habitats.

Migration corridors are an additional habitat requirement for many Arctic fish since feeding, spawning, and overwintering habitat for an individual fish are not always proximate to each other, necessitating seasonal or annual movements. Strategies to satisfy shifting habitat needs can be different even within local populations of the same species, but it is well documented that many fish migrate locally or even extensively between major drainages in order to reach suitable habitat at various life history stages (Morris 2000, Morris 2003, Bond and Erickson 1985, Strange 1985). Annual waterbody connectivity and flow regimes play a major role in determining how much potential habitat is actually accessible (MJM Research 2005a and 2007e).

3.3.4.2 NPR-A Fish Habitat Units

Within the NPR-A, differences in topography and other physical environmental factors distinguish various areas as unique regarding aquatic habitat characteristics. Based on these differences, six fish habitat units were delineated for the NPR-A (Table 3-17). These were modified from units initially identified during the 105(c) land use study (USDOI BLM 1978a) in further considering the physiographic regions established by Warhaftig (1965), and USGS hydrologic units (Map 3.3.4-1). They include the Lower Colville Unit, Mountain Headwaters Unit, Coastal Plain Unit, Foothills Unit, Utukok/Kokolik Unit, and Coastal Marine Unit (CMU). Information on the units is summarized here from Warhaftig (1965), USDOI BLM (1978), Bendock (1979a), Hablett (1979), Morris (1981), Nelson (1981), Craig and Skvorc (1982), Gusey (1982), Craig (1984a), Craig (1984b), Fechhelm et al. (1984), Craig and Schmidt (1985), Mellor (1987), Gusey (1988), Craig (1989a), Weingartner (1997), Kostorhys et al. (2000), Oswood et al. (2000), Weingartner and Okkonen (2001), Kostorhys et al. (2003), Weingartner et al. (2005), Battelle (2006), and Arp and Jones (2009).

The extent of streams and lakes providing potential fish habitat in the NPR-A Fish Habitat Units is included in Table 3-17, calculated from the USGS National Hydrography Dataset While not all streams and lakes are fish-bearing, this analysis provides a representative index of aquatic habitat in the NPR-A, a majority of which is utilized by fish. All stream segments (National Hydrography Dataset “flowlines” not within National Hydrography Dataset “waterbodies”) were used since they are connected at some point to higher order lotic systems, but only lakes (National Hydrography Dataset “waterbodies”) greater than 10 acres in the lake dataset were included in order to better represent likely fish habitat. There is no size-based definition of a lake that is widely accepted by the scientific community. However, 10 acres has been used as a practical breakpoint in other lake-rich regions (Minnesota Department of Natural Resources 2011) and in historical recognition of public waters, partly based on the right to fish, where greater than 10 acres was used as a legal definition (Pond Ordinance of 1641; Alaska Department of Natural Resources 2010). Furthermore, the National Hydrography Dataset uses a "10-acre rule" which classifies lakes of 10 acres or less as "insignificant" features for drainage network hydrologic computations (USGS 2000).

Table 3-17. Extent of potential fish habitat in NPR-A fish habitat units[1]

NPR-A fish habitat unit	Surface area within NPR-A (acres)[2]	Stream miles[2]	Number of lakes (>10 acres)	Lakes (>10 acres) surface area (acres)[B]
Lower Colville	1,128,200	3,400	615	31,400
Mountain Headwaters	4,201,000	7,700	328	14,700
Coastal Plain	8,986,800	9,900	14,397	1,758,500
Foothills	4,673,900	7,200	403	24,700
Utukok/Kokolik	3,126,700	5,900	581	49,700
Coastal Marine	428,600	(Coastline Length = 1,154 miles)		

1. BLM-managed lands only; surface area, stream, and lake calculations from National Hydrography Dataset; coastline length derived from 63,360 USGS Quad Map.
2. Rounded to the nearest hundred.

While lakes less than 10 acres can provide fish habitat, waterbodies under this size in the NPR-A are disproportionately isolated and, as such, less likely than larger lakes to furnish fish habitat except seasonally during spring flooding when they might be connected to streams or other lakes. The 10-acre breakpoint was confirmed to be a reasonable and practical breakpoint in the NPR-A by closely reviewing the National Hydrography Dataset and high-resolution aerial imagery in a region where ground conditions are well known. Numerous small areas of ponded water, often extremely shallow and/or ephemeral, are delineated as individual lakes in the National Hydrography Dataset and the inclusion of these would grossly overestimate the total number of lakes providing potential fish habitat. Across the entire NPR-A, for example, using all lake delineations (116,888 lakes) and using greater than 5 acres as a breakpoint (26,937 lakes) increases the estimate of the number of lakes by 581 percent and 57 percent, respectively, over the estimate using greater than 10 acres (17,157 lakes).

Lower Colville Unit

The Lower Colville Unit consists of the Colville River from the mouth of the Etivluk River downstream to its delta on the Beaufort Sea. The Colville River is the largest river draining the Alaskan Arctic and its size and unique land features set it apart from other NPR-A rivers. High bluffs, frequent rock outcroppings, and coarse substrate typify much of the landscape throughout this unit. However, due to the extensive length of the Lower Colville Unit, some distinct transitions in habitat type are notable along its course. From the Etivluk River down to the Killik River, the Colville River is predominantly a single, narrow channel with few deep pools and an abundance of gravel. Downstream of the Killik River to Ocean Point, the Colville River is less confined and is characterized by braided channels, numerous deep pools, and gravel and sand substrate. Between Ocean Point and the terminus of the Colville River in the Beaufort Sea, the river is dominated by fine sediments and a single, deep channel that transitions into several channels as it spreads through the delta. Most of the Colville River watershed downstream from the Etivluk River is outside of the NPR-A boundary; only lands to north and west of the river are managed by BLM. However, major tributaries flowing into the Colville River from the south and the east, such as the Killik, Chandler, Anaktuvuk, and Itkillik rivers, heavily influence the fish resources on BLM lands that are part of the Lower Colville Unit.

The extent of lake habitat for fish in the Lower Colville Unit is very sparse in comparison to the riverine environment that dominates the drainage. Relatively few lakes are present and only a limited number are known to be deep enough for overwintering habitat.

Mountain Headwaters Unit

The Mountain Headwaters Unit includes the upper Colville River, upstream of the Etivluk River mouth, and its tributaries. This unit is distinguished by the major tributaries that originate on the northern slopes of the Brooks Range, including the Nuka, Kiligwa, Kuna, Ipnavik, Etivuluk, and Nigu rivers. These rivers are characterized by single channels in narrow valleys, medium to large gravel substrates in the lower reaches, and much steeper gradients than other rivers of the NPR-A. Flow is especially responsive to precipitation events that lead to major fluctuations in discharge and turbidity; at any time during the summer the rivers can be nearly discontinuous or at flood stage. The portion of the Colville River in the Mountain Headwaters Unit is reflective of these mountain tributaries, with similarly flashy flows and sand and small gravel substrate that settles out beyond their mouths. The Awuna River is also included in the Mountain Headwaters Unit, although originating on the north side of the Colville River. While it courses through less steep terrain than the other tributaries, it is similarly shallow and can become discontinuous in mid or late summer during long dry periods. Regarding channel habitat in the Mountain Headwaters Unit, only the lower Etivuluk River, a spring in the mid-Ipnavik River, and portions of the Colville River downstream of the Kuna River are believed to provide potential overwintering areas.

There are relatively few lakes present in the drainages flowing north out of the Brooks Range. About 10 of these have a maximum depth of 7 feet or more, with 6 greater than 10 feet that provide consistent deep water habitat even during the coldest winters and represent much of the overwintering habitat available in the Mountain Headwaters Unit. These are Swayback, Tukuto, Betty, Akuliak, and Etivilik lakes, and an unnamed lake in Inyorurak Pass. The other, shallower lakes may provide spawning habitat for spring or early summer spawners as well as valuable feeding habitat. There are numerous small ponds and potholes along the upper Colville and Awuna river drainages, primarily in the floodplain. Nearly all of these waterbodies are shallow and provide limited fish habitat. However, ponds that remain connected to the rivers and streams, at least intermittently, could provide warm, productive feeding habitat.

Coastal Plain Unit

The Coastal Plain Unit is the largest fish habitat unit in the NPR-A. Although numerous major waterbodies are included in this unit, the primary systems include Fish Creek, Teshekpuk Lake/Miguakiak River, and the Ikpikpuk, Chipp, Oumalik, Topagoruk, Meade, Inaru, Kugrua, and Kuk rivers. While some of these originate in the foothills, aquatic habitat characteristics differ enough between the Coastal Plain Unit and Arctic Foothills physiographic provinces to merit separate fish habitat units, leading to the partitioning of some major watersheds along the southern unit boundary. The Coastal Plain Unit is characterized by extremely low gradient terrain that strongly influences aquatic habitat features and morphology. Rivers and streams are generally slow-moving with many unstable banks, and substrates are dominated by sand and silt with relatively few isolated areas of gravel. A majority of the annual flow occurs during spring breakup when large expanses of land tend to be inundated by water. Flow is reduced significantly by mid to late summer and can even become discontinuous, depending on precipitation. Deep river pools and extensive deltas provide overwintering habitat in channels.

Outside of the major river corridors, the predominant aquatic habitat type in the Coastal Plain Unit consists of complicated networks of lakes and small streams. The landscape is dominated by a dense concentration of lakes that cover nearly 20 percent of the unit's surface area. These lakes vary greatly by depth, with a majority of the deepest lakes concentrated in the central Coastal Plain Unit (Map 3.3.4-1); however, lakes deep enough to provide overwintering habitat are present throughout the unit. Small streams that are often integrated with lakes in lower-order drainages are those described as "beaded" because of the dominance of deep pools that occur along thermally degraded ice-wedges and are connected by narrow channels. These beaded stream/lake complexes represent important, extensive fish habitats in the Coastal Plain Unit.

Foothills Unit

The Foothills Unit is comprised of the upper reaches of watersheds that are otherwise included in the Coastal Plain Unit. Major systems include the upper Ikpikpuk, Kigalik, Titaluk, upper Oumalik, upper Topagoruk, Usuktuk, upper Meade, Avalik, Ketic, Omikmuktusuk, Kaolak, and upper Ivisaruk rivers. The Foothills Unit differentiates significantly from the Coastal Plain Unit in having steeper gradients, more coarse substrates (gravel and sand), and relatively few lakes; aquatic habitat largely consists of very shallow rivers and streams. A lack of deep pools in most of the flowing systems means that overwintering habitat in channels is absent or sparse. Similar to the Coastal Plain Unit, a majority of flow occurs during breakup and some streams can cease flowing or become discontinuous prior to freeze-up.

The scant presence of lakes in the Foothills Unit indicates a significant difference from the way that aquatic habitats are utilized by fish in the downstream reaches of these watersheds. Most of the lakes are assumed to be relatively shallow and provide only seasonal feeding habitat. Although a small number of lakes are known to be deep enough to support overwintering, these are extremely rare relative to the size of the habitat unit.

Utukok/Kokolik Unit

The Utukok/Kokolik Unit includes the portions of the Utukok and Kokolik river drainages that are within the NPR-A boundary. The upper Utukok River channel varies between braided sections in flat areas and incised sections where there is foothill topography. Downstream of Carbon Creek the river meanders in a single channel to the coast, with relatively little additional water from tributaries; Carbon Creek is the largest tributary and may provide the only substantial fish habitat aside from the main river channel. Large gravel is abundant in the incised sections but smaller-sized substrate is more common in the rest of the river. The upper Kokolik River flows through a succession of hills down to Avingak Creek, with relatively few braided channels. The substrate in this section is unique amongst most other rivers of the NPR-A, with cobble and boulders present where the channel is incised and several stretches of bedrock. Downstream of Avingak Creek the river typifies a shallow, meandering tundra river, with gravel size decreasing towards the coast. Similar to rivers in the Mountain Headwaters Unit that originate in the northern Brooks Range, flow and turbidity in the Utukok and Kokolik rivers are particularly responsive to rainfall events. Overwintering habitat in the Utukok River is likely available only downstream of Carbon Creek, aside from an isolated spring documented in the upper basin. In addition to probable overwintering habitat in the Kokolik River delta, some deep pools exist in the upper, incised reaches that may provide winter refuge.

Most of the lakes in the Utukok River drainage are in the downstream reaches and many are not strongly connected to the main river channel. Some of the lakes on the coastal plain may feasibly provide overwinter habitat. The majority of lakes within the Kokolik River drainage are also in the lower portion of the drainage and, similar to the Utukok River, many of these lakes lack well-defined outflow channels connecting them to the river. Several of the lakes are relatively large and may provide important fish habitat, although the characteristics of these lakes are not well documented.

Coastal Marine Unit

Many fish inhabiting freshwater within the NPR-A boundary utilize coastal habitat seasonally or at some time during their life cycle. Some marine species also migrate into freshwater habitats of the NPR-A. Therefore, the nearshore marine environments of the northeast Chukchi Sea and western Beaufort Sea are an extension of the inland fish habitat within the NPR-A and are designated as the Coastal Marine Unit. The outer boundary of the Coastal Marine Unit is designated as 10 kilometers offshore, as this is typically the greatest extent of the estuarine band that forms along the coast during the summer. However, since the actual width of the estuarine band varies throughout the year, the Coastal Marine Unit includes both brackish and marine waters. Within the Coastal Marine Unit, the nearshore zone less than 2 meters deep characteristically has the greatest fish densities and is dominated by fish that also utilize freshwater at some time during their lifecycle. While much of the Coastal Marine Unit waters are outside of the NPR-A boundary, many of the substantial bays and lagoons, such as Kasegaluk Lagoon, Peard Bay, Elson Lagoon, Dease Inlet, and Admiralty Bay, are part of the NPR-A.

A number of similar physical processes occur along the Chukchi and Beaufort Sea coastlines. Tidal fluctuations are low, with amplitude rarely exceeding 1 foot. Winds can change the water level more than tides and can cause lagoons to rise by 2 to 3 feet, or similarly reduce lagoon depths, depending on the direction of wind, with extreme storm surges normally occurring in the fall. Salinity ranges from about 10 to 35 milligrams per liter, depending on distance from the coast, depth, and local freshwater input. The coasts are covered in ice for eight to ten months each year, with most of the ice along the coastline being bottom-fast, or anchored to the substrate, to about 2 meters in depth by late winter. However, salt exclusion during the formation of ice can also create highly saline pockets of unfrozen water which can reach lower temperature limits near 28 °F (-2 °C). Deep holes in coastal water or in adjacent river deltas that persist after maximum freezedown do provide overwintering habitat for some species, depending on physiological tolerance of temperature and salinity.

Despite these broad similarities along both coastlines, there are notably different fish habitat conditions in the Coastal Marine Unit for the two seas. In the northeast Chukchi Sea, the offshore distance (20 to 30 kilometers) of the relatively warm Alaska Coastal Current flowing north from the Bering Sea and the comparatively low volume of freshwater discharging into the sea make its coastline colder, more saline, and less biologically productive than the western Beaufort Sea coast. In the western Beaufort Sea, a combination of nearshore currents and significant freshwater discharge creates a discrete band of warmer, brackish water along the coast that provides highly productive feeding habitat for fish. These habitat conditions do not generally exist along the northeast Chukchi Sea coast, although similar conditions can be present in isolated inlets. The northeast Chukchi Sea coast is characterized by relatively few inlets and more sand and gravel beaches than mud flats, while the Beaufort Sea coast is typified by an irregular shoreline and abundant mud flats and protected lagoons and inlets. The Beaufort Sea also has substantially more coastline and delta habitat that provides potential overwintering refuge for fish and, with more significant freshwater runoff pushing into the sea, there are likely fewer areas of high salinity under the ice in the fall. The general result of these differences is more anadromous fish in the Coastal Marine Unit along the Beaufort Sea compared to more marine fish in the Coastal Marine Unit along the Chukchi Sea.

3.3.4.3 Fish Species

The greatest broad-scale fish inventory effort in the freshwater environment of the NPR-A took place as part of the 105c Land Use Study during the late 1970s (Netsch et al. 1977, Bendock 1979a, Hablett 1979, USDOI 1978), with very little information existing prior to that time. Other work conducted in coastal areas in the 1980s was largely related to oil and gas leasing in the region. While only a few isolated fish studies took place in the 1990s, there was a substantial increase in fisheries work between 2000–2010, largely related to a resurgence in interest in the oil and gas resources of the NPR-A. Additionally, efforts to document subsistence fish harvest over about the last 30 years have provided further information regarding the distribution of fish species.

Despite the existing information on fish in the NPR-A there is still much unknown about spatial and temporal distribution within its boundaries, especially considering its vast geographic size. Moreover, most of the freshwater fish studies conducted in the NPR-A have focused on species occurrence and movements, with population estimates lacking. A majority of work has also been conducted in the summer, which influences species found and habitats used.

Although life history strategies vary among species and even within populations, Arctic fish can be classified into three general categories: freshwater, anadromous, and coastal marine (Table 3-18). The following section provides a brief discussion on the distribution of fish species found in the NPR-A and adjacent waters. More detailed information can be found in the following references.

Table 3-18. Fish species found in the NPR-A and adjacent waters

Common name	Scientific name	Iñupiaq name
Freshwater species		
Alaska blackfish	*Dallia pectoralis*	Iłuuqiniq
Arctic char	*Salvelinus alpinus*	—
Arctic grayling	*Thymallus arcticus*	Sulukpaugaq
Burbot	*Lota lota*	Tittaaliq
Lake trout	*Salvelinus namaycush*	Iqaluaqpak
Longnose sucker	*Catostomus catostomus*	Milugiaq
Ninespine stickleback	*Pungitius pungitius*	Kakalisaauraq
Northern pike	*Esox lucius*	Siulik
Round whitefish	*Prosopium cylindraceum*	Savigunnaq
Slimy sculpin	*Cottus cognatus*	Kanayuq
Anadromous species		
Arctic cisco	*Coregonus autumnalis*	Qaataq
Arctic lamprey	*Lampetra japonica*	Nimigiaq
Bering cisco	*Coregonus laurettae*	Tiipuq
Broad whitefish	*Coregonus nasus*	Aanaaqłiq
Chinook salmon	*Oncorhynchus tschawytscha*	—
Chum salmon	*Oncorhynchus keta*	Iqalugruaq
Coho salmon	*Oncorhynchus kisutch*	—
Dolly varden	*Salvelinus malma*	Iqalukpik
Humpback whitefish	*Coregonus pidschian*	Piquktuuq
Least cisco	*Coregonus sardinella*	Iqalusaaq
Pink salmon	*Oncorhynchus gorbuscha*	Amaqtuuq
Rainbow smelt	*Osmerus mordax*	Iłhauġniq
Sockeye salmon	*Oncorhynchus nerka*	—
Threespine stickleback	*Gasterosteus aculatus*	—
Coastal marine species[1]		
Arctic cod	*Boregogadus saida*	Uugaq
Arctic flounder	*Liopsetta glacialis*	Nataaġnaq/Puyyagiaq
Capelin	*Mallotus villosus*	Panmigriq
Fourhorn sculpin	*Myoxocephalus quadricornus*	Kanayuq
Pacific herring	*Clupea harengus*	Uqsruqtuuq
Saffron cod	*Eleginus gracilis*	Uugaq

[1] Principal (most commonly caught) coastal fish only.

Information is synthesized here from numerous references. Sources reviewed to document distribution and pertinent biology, taxonomy, and life history characteristics of fish in the NPR-A and nearby coastal and marine areas include: Walters (1955), McPhail and Lindsey (1970), Kogl (1971), Alt and Kogl (1973), Scott and Crossman (1973), Craig and McCart (1974), Furniss (1974), Kogl and Schell (1974), Sloan (1976), McLean and Delaney (1977), Netsch et al. (1977), USDOI BLM (1978), Alt (1979), Bendock (1979a, b), Hablett (1979), Ivie and Schneider (1979), Schneider and Bennet (1979), Bendock (1980), Morrow (1980), Craig and Haldorson (1981), McElderry and Craig (1981), Morris (1981), Nelson (1981), Bendock (1982), Craig and Schmidt (1982), Craig and Skvorc (1982), Griffiths and Gallaway (1982), Gusey (1982), West (1982), Bendock (1983), Critchlow (1983), Moulton and Dew (1983), Bendock and Burr (1984), Craig (1984a, b), Fechhelm et al. (1984), Moulton and Fawcett (1984), Craig and Schmidt (1985), Craig and Haldorson (1986), Fawcett et al. (1986), Cannon et al. (1987), Moulton and Tarbox (1987), Fechhelm and Fissel (1988), Gusey (1988), Winters et al. (1988), Craig (1989a, b), Gusey (1989), Burns (1990), Fechhelm and Griffiths (1990), Arvey (1991), Braund & Associates and UAAISER (1993), Philo et al. (1993a, b), Bickham et al. (1997), Colonell and Gallaway (1997), Everett et al. (1997), Fuller and George (1997), Reist et al. (1997), Kline and Goering (1998), MJM Research (1998), Moulton (1998), Babaluk et al. (2000), MJM Research (2000a,b,c), Reanier (2000), Fechhelm and Griffiths (2001), Kassam and WTC (2001), MJM Research (2001a,b), Mecklenburg et al. (2002), MJM Research (2002a, b, c, d, e; 2003a, b, c, d, e, f, g), Morris (2003), MBC (2004), MJM Research (2004a, b; 2005a, b, c, d; 2006a, b), Morris et al. (2006), OASIS and LCMF (2006), ASRC (2007), Murphy et al. (2007); MJM Research (2007a, b, c, d, e, f), Moulton et al. (2007), MJM Research (2008a, b, c; 2009), ADFG (2010a, b), Johnson et al. (2010), Moulton et al. (2010).

Freshwater Fish

Freshwater fish species largely remain within river, stream, and lake systems year-round. While a small number of individuals may venture into coastal areas where waters are brackish during summer, species discussed here predominantly remain in inland waters.

Arctic grayling are the most widespread fish species in the NPR-A. During the NPR-A 105c investigations, nearly a quarter of the freshwater fishes captured were grayling. They are distributed throughout all of the major river drainages, including many small tributaries and lakes, ranging from the coast to the upper-most reaches of mountain headwaters. While much less common in deltas and coastal areas, Arctic grayling have been encountered incidentally along the Beaufort Sea coast and in Kasegaluk Lagoon. Extensive seasonal movements have been observed in the greater Fish Creek region, with some individuals returning to the same small tributaries for feeding each summer.

Round whitefish are the only coregonid in the NPR-A that are found almost exclusively in freshwater. They distribute throughout the Colville River in the Lower Colville Unit and, within the Mountain Headwaters Unit, utilize the upper Colville, Awuna, and Etivlik rivers, and many headwater lakes such as Tukuto, Akuliak, and Etivlik lakes. In the Coastal Plain Unit, occurrence is more common in the east, although they have also been noted far to the west in the Kuk River. Their known range extends into Foothills Unit habitat, including the Avalik River.

Lake trout primarily inhabit deep lakes and are especially concentrated in the headwaters of the Etivilik River drainage in the Mountain Headwaters Unit and the east-central portion of the Coastal Plain Unit to the west and north of Fish Creek, including a notable population inhabiting Teshekpuk Lake. While mainly residing in lakes, some also utilize riverine systems, having been documented in the middle and lower reaches of the Colville River in the Lower Colville Unit and the Utukok River in the Utukok/Kokolik Unit. While it has been long-believed that lake trout are intolerant of salt water, recent work in northern Canada found evidence of some lake trout utilizing coastal marine habitat. Nevertheless, no lake trout have been documented along coastal brackish waters of the NPR-A.

Although **burbot** occur across a wide geographic extent in the NPR-A, their abundance is relatively sparse. However, their distribution and abundance is likely underestimated since some of the more common sampling gears are not efficient at capturing them. Burbot are commonly found in the Lower Colville Unit and to a much lesser extent in other habitat units. Their use of the Colville River extends upstream into the Mountain Headwaters Unit, including the mainstem river up as far as the confluence with the Ipnavik River, and the lower Etivluk River. Burbot are found infrequently within the lakes and streams of the Coastal Plain Unit, with major drainages including Fish Creek, Teshekpuk Lake, and the Ikpikpuk, Meade, and Kuk rivers. Radio-tagged burbot in the Fish Creek drainage have been observed moving long distances, probably in search of sufficient food resources. Within the Foothills Unit, most of the documented captures have been in the western portion in the subsistence fishery that utilizes the Kaolak, Ketic, and Avalik rivers.

Similar to burbot, the east-west range of **northern pike** spans the NPR-A, although catch rates indicate that their density is relatively low. Their greatest abundance is in the central Coastal Plain Unit in the Ikpikpuk River drainage and lakes in the region, occurring less commonly in other parts of the Coastal Plain Unit. Northern pike have also been captured in the headwaters of the Ikpikpuk River (Maybe Creek) in the Foothills Unit and in the middle and lower reaches of the Colville River in the Lower Colville Unit.

Arctic char and Dolly Varden have a complicated taxonomic history in Arctic North America. Up through the 1980s the two names were sometimes used interchangeably, and in other cases identification depended on a researcher's opinion on taxonomic differentiation. Since the early 1990s the general consensus of fishery scientists working on Alaska's North Slope has been that Arctic char only occur as a resident lake species, while Dolly Varden have resident and anadromous forms that utilize multiple habitats. Slight differences in external characteristics help to support this. Based on this division, historical studies referring to Arctic char in major rivers and coastal areas of the NPR-A are presumed to be Dolly Varden. References to Arctic char or Dolly Varden in other habitats are accepted as accurate, although some historical designations could potentially be erroneous. Accordingly, Arctic char are rare in the NPR-A, but have been captured in the Miguakiak River, essentially an extension of western Teshekpuk Lake, and other lakes of the north-central Coastal Plain Unit. Dolly Varden distribution is discussed below under Anadromous Fish.

Longnose sucker are most commonly associated with the Colville River in both the Lower Colville Unit and Mountain Headwaters Unit, and tributaries such as the Awuna and Etivluk rivers. They are also abundant in the Ikpikpuk River system in the Coastal Plain

Unit and the Foothills Unit. Outside of these drainages, they are rare and have not been observed in waters that drain into the Chukchi Sea.

Ninespine stickleback are fairly ubiquitous in the NPR-A, occurring in all the freshwater fish habitat units. They have a broad range of salinity tolerance and can utilize brackish and marine waters, with some anadromous forms, also indicating use of the Coastal Marine Unit. They occur in the densest numbers across the Coastal Plain Unit and are extremely common in lakes, including many shallow or disconnected lakes that don't provide viable habitat for any other fish species.

Slimy sculpin distribution in the NPR-A is comparable to that of ninespine stickleback, being present in all of the freshwater fish habitat units, but generally they are less widely distributed and present in significantly lower numbers. Furthermore, slimy sculpin have obligate freshwater populations and do not make use of the Coastal Marine Unit.

Alaska blackfish occur in low numbers in the Lower Colville Unit, most notably in the Colville River Delta channels and associated lakes, and this represents the eastern limit of their range in northern Alaska. They are common in multiple habitats across the Coastal Plain Unit, ranging from the Fish Creek watershed in the east to the Kuk River watershed in the west, and are especially prevalent in heavily vegetated lake habitat.

Anadromous Fish

Historical scientific terminology describing fish migrations between saltwater and freshwater includes multiple categories (Myers 1949). For example, "diadromous" refers to all migratory fish which utilize both of those habitat types, "anadromous" describes fish that spend a majority of their time in saltwater and spawn in freshwater, "catadromous" describes fish that spend a majority of their time in freshwater and spawn in saltwater, and "amphidromous" describes fish that make many migrations between freshwater and brackish or marine water for purposes other than spawning, such as feeding and overwintering. However, it is now commonly accepted that "anadromous" can be used broadly to mean "breeding in fresh water but spending at least part of the life cycle in the ocean" (Craig 1989a). This is consistent with Alaska Department of Fish and Game legal use, as exemplified by the Anadromous Fish Act (AS 16.05.871) and the Anadromous Waters Catalog (5 AAC 95.011) (ADFG 2010a), comprehensive sources describing fish species in Arctic Alaska and Canada (McPhail and Lindsey 1970, Scott and Crossman 1973, Morrow 1980, Mecklenburg et al. 2002), and the typical interpretation by the public at large. As such, this is the definition of "anadromous" that will be utilized throughout this document and is important to note for more technical readers.

Waterbodies currently recognized for various anadromous fish species as part of the Anadromous Waters Catalog are shown on (Map 3.3.4-2). A strict documentation and review process must occur in order for a waterbody or species to be approved for the Anadromous Waters Catalog. While notable progress has been made in expanding the Anadromous Waters Catalog for the Arctic in recent years, it does not reflect the entire distribution for any given species. Nevertheless, it is a critical document since it represents the current waterbodies protected under AS 16.05.871. The following discussion on the distribution of anadromous fishes is based on reports and articles as well as the Anadromous Waters Catalog. Since all of these species have at least some anadromous forms in their populations, occurrence in the Anadromous Waters Catalog is implicit, although some species are more prevalent than others in that habitat unit.

Broad whitefish are common in all the NPR-A watersheds draining into the Beaufort Sea and are one of the most abundant anadromous species found in adjacent coastal waters, but are much less abundant in NPR-A watersheds draining into the Chukchi Sea. They are found throughout the Lower Colville Unit and to a lesser extent, the Mountain Headwaters Unit, including the Etivluk and Awuna rivers, Betty Lake, and the mainstem of the Colville River up to the Ipnavik River. Broad whitefish heavily utilize the dense network of stream/lake habitats in the Coastal Plain Unit and, as such, are widespread across this unit. Use of Foothills Unit waters, upstream of the Coastal Plain Unit habitat, is more infrequent, although they have been located in the Ivisaruk and Avalik rivers. Radio-tagged broad whitefish in the Fish Creek and Teshekpuk Lake regions have provided insight into the complicated and variable life history strategies these fish use. Many individuals travel extensive distances seasonally in order to access suitable feeding, spawning, and overwintering habitat. Fish may utilize multiple river drainages or make more local movements within a single river drainage.

Humpback whitefish have a comparable regional distribution to broad whitefish in the NPR-A, although they are much less abundant. They are found in the Lower Colville Unit upstream as far as the Killik River and throughout Coastal Plain Unit drainages flowing into the Beaufort Sea. Known use of the Foothills Unit is limited to the upper Meade River. Use of the northeast Chukchi Sea waters and its freshwater drainages is extremely limited. However, humpback whitefish have been captured in Kasegaluk Lagoon and outside of the barrier islands in that area. Although more research in northern Alaska has been focused on broad whitefish, studies in the Canadian Arctic demonstrate that humpback whitefish also have multiple behavioral patterns, with individuals making seasonal migrations and using freshwater and brackish water habitats to varying degrees.

Least cisco can utilize a wide range of habitats and several forms inhabit the watersheds of the North Slope, contributing to a wide distribution. Some are anadromous while others strictly remain in fresh water, and dwarf forms in some locations further complicate intra-specific differences. Similar to broad and humpback whitefish, the complex stream and lake habitats of the Coastal Plain Unit appear to be highly suitable for least cisco and they are found in the greatest abundance in that habitat unit, occurring in all major drainages. Use of these systems upstream of the coastal plain boundary appears to be limited, with the Avalik River being the only Foothills Unit waters where they have been reported. Their distribution also comprises the Lower Colville Unit and Mountain Headwaters Unit. In these habitat units they make use of the Colville River, from the delta upstream to at least to the confluence with the Kuna River, and they also inhabit some of the mountain headwater lakes, including Tukuto Lake, Akuliak Lake, and a large, unnamed lake in Inyorurak Pass. Anadromous least cisco forms are likely a major component of populations found in the Coastal Plain Unit, as they are especially plentiful in the Beaufort Sea portion of the Coastal Marine Unit. Although to a lesser degree, anadromous individuals are also encountered in the Coastal Marine Unit along the northeast Chukchi Sea, as they are reported in Wainwright Inlet and nearby coastal areas and even seaward of the barrier islands near Point Lay.

The primary distribution of **Arctic cisco** in and near the NPR-A is limited to the Coastal Marine Unit along the Beaufort Sea during summer and the lower Colville River portion of the Lower Colville Unit during winter. Strong evidence suggests that most, if not all, Arctic cisco found in Alaska originate from spawning grounds in the Mackenzie River system of Canada; no spawning areas have been identified in Alaska. In spring, newly hatched fish are flushed into Canadian coastal waters where many young-of-the-year are transported westward to Alaska by wind-driven currents. Fish typically remain associated with the Colville River until the onset of sexual maturity beginning at about age 7, at which point they migrate back to the Mackenzie River to spawn. There is evidence that some individuals drift or swim west of the Colville River, as incidental catches have been noted in the Coastal Plain Unit in eastern lakes, including Teshekpuk Lake, and in the lower Ikpikpuk and lower Kuk rivers. Arctic cisco have even been reported west and south of Point Barrow in the lower Utukok River in the Utukok/Kokolik Unit and Kasegaluk Lagoon in the northeast Chukchi Sea Coastal Marine Unit.

Bering cisco are extremely similar in appearance to Arctic cisco, only separable by the number of gill rakers on the lower limb of the first arch. Their life history is also very comparable, with juveniles migrating out to sea from freshwater during their first summer. They feed and overwinter primarily in coastal and estuarine areas, rarely venturing into freshwater habitats, until they reach maturity at about 5 to 8 years of age. Upon maturing, they return to the Yukon, Kuskokwim, or Susitna rivers to spawn, and these rivers maintain the only known populations worldwide. In the region of the NPR-A, they are found more often in the western Coastal Marine Unit, in the northeast Chukchi Sea, than they are in the Coastal Marine Unit of the Beaufort Sea. They are rarely encountered in freshwater of the NPR-A, but have been captured sporadically in the Coastal Plain Unit, including the Kuk and Ivisaruk rivers and the Teshekpuk Lake region, and in the Avalik River in the Foothills Unit.

In the northeast Chukchi Sea and western Beaufort Sea, all five species of **Pacific salmon (pink, chum, king, coho, and sockeye salmon)** have been reported. Pink and chum salmon occur in the greatest numbers, although their abundance is still especially low compared to other fish species in the region. Pink and chum salmon adults are documented utilizing the Kokolik and Utukok rivers in the Utukok/Kokolik Unit, the Kuk, Kugrua, Chipp, Ikpikpuk, and Ublutuoch rivers and Fish and Judy creeks in the Coastal Plain Unit, and the Colville River up to the upstream extent of the Lower Colville Unit. Additionally in the Coastal Plain Unit, pink salmon have been captured in the Ivisaruk, Kungok, Mikigealiak, and Miguakiak rivers and chum salmon have been captured in the Meade River. In the Foothills Unit, pink salmon are known to use the Ketik and Kaolak rivers. Knowledge regarding specific spawning areas is very limited. The capture of any juvenile salmon in the Arctic is extremely rare, although chum salmon smolts have been captured in the Colville River Delta.

King salmon are much more uncommon in the NPR-A and its coastal areas and sockeye and coho salmon are rare. Freshwater captures are often limited to only one or a few individuals. King salmon have been identified in the Kuk and Ublutuoch rivers and Fish Creek in the Coastal Plain Unit, in the Kaolak and Avalik rivers in the Foothills Unit, and in the portion of the Colville River in the upper Lower Colville Unit. Sockeye salmon have been very infrequently encountered in the downstream reaches of the Lower Colville Unit and the Ublutuoch River in the Coastal Plain Unit. Reports of coho salmon are limited to individuals migrating up the Kuk River in the Coastal Plain Unit and further upstream into the Foothills Unit in the Kaolak River. Compared to the Beaufort Sea, these salmon species are more likely to be present in the northeast Chukchi Sea as migrants from the southeast Chukchi and Bering seas. In 17 years of summer coastal sampling in the Prudhoe Bay region of the Beaufort Sea (1981–1997), only one king salmon and zero sockeye or coho salmon were captured. However, in the recent decade there have been some years with notable increases in king salmon captures in the Elson Lagoon subsistence fishery further to the west (George, C., personal communication, 2006).

Consensus on differentiating **Dolly Varden** and Arctic char on the North Slope has only occurred in the last two decades. See the above discussion on Arctic char for more details. Although Dolly Varden can potentially demonstrate resident behavior, they are considered to be predominantly anadromous in the Arctic, with most being found in rivers and coastal areas. Their distribution in the NPR-A is discontinuous, with the largest concentrations in the far east and in the far west. They are well documented in the Kokolik and Utukok rivers in the Utukok/Kokolik Unit and in the Colville River to the upstream extent of the Lower Colville Unit. Although the Colville River is utilized by a substantial number of Dolly Varden, it is believed that this river is principally a migratory corridor to spawning and overwintering areas in tributaries to the east, outside of the NPR-A boundary, including the Chandler, Anaktuvuk, and Itkillik rivers. Dolly Varden are uncommon across the Coastal Plain Unit, but have been found in the Fish Creek drainage. Their use of coastal water is extensive, having been captured in the Coastal Marine Unit within lagoons and inlets as well as outside of the barrier islands.

Rainbow smelt enter freshwater to spawn in the spring but otherwise prefer brackish coastal areas and deltas; they are known to occur throughout the Coastal Marine Unit in both the Beaufort and Chukchi seas. Freshwater use is typically limited to the lower reaches of rivers, only up to a few miles. Their presence is documented in the Colville River within the Lower Colville Unit, the Chipp, Kuk, and Avak rivers in the Coastal Plain Unit, and the Kokolik River in the Utukok/Kokolik Unit, but the actual freshwater distribution is likely more widespread.

With both anadromous and resident freshwater forms, **threespine stickleback** can be found in a wide variety of habitats, ranging from inland lakes and rivers to well offshore in marine waters. Most captures in the NPR-A have been either in the Coastal Marine Unit or in near-coastal areas such the lower reaches of rivers (Moulton, L., personal communication, 2010). Occurrence in the Coastal Marine Unit is documented in Wainwright Inlet as well as Elson Lagoon, where they were particularly abundant. Freshwater occurrence includes the Chipp and Miguakiak rivers and Teshekpuk Lake in the Coastal Plain Unit and the Colville River Delta portion of the Lower Colville Unit.

Most **Arctic lamprey** are anadromous and parasitic, although some portions of the population can be resident and non-parasitic, as well. While they are not commonly observed in the NPR-A or adjacent coastal waters, range descriptions for the species include the entire coastal plain in the Alaskan Arctic and their distribution is considered to be almost circumpolar. Low detection could be partly attributed to the fact that most scientific sampling gears are extremely poor at capturing lamprey, they are not targeted in the subsistence fishery, and preferred freshwater habitat is muddy edges of rivers and lakes. As such, their actual presence in freshwaters and the Coastal Marine Unit is largely unknown.

Coastal Marine Fish

Fish classified as marine species essentially spend their lives at sea, although some may migrate into nearshore, brackish coastal waters during summer or even travel considerable distances upriver. During winter, most of these species move offshore to warmer marine areas or utilize suitable estuarine habitat. These seasonal movements vary among species and correspond to requirements and strategies regarding spawning, feeding, and overwintering, with temperature and salinity largely regulating distribution. Over 60 fish species (anadromous and marine) are known to utilize coastal waters along the western Beaufort Sea (Craig 1984a), with a greater number for coastal waters of the northeast Chukchi Sea (Morris 1981, Craig and Skvorc 1982). Species diversity is higher for the northeast Chukchi Sea since fish populations are consistently enhanced by individuals moving north through the Bering Straits and the southeast Chukchi Sea (defined as south of Point Hope). Despite the number of fish species potentially present in the Coastal Marine Unit of the NPR-A, six species comprise the majority of marine fish captured. These are fourhorn sculpin, Arctic flounder, saffron cod, Pacific herring, capelin, and Arctic cod.

Fourhorn sculpin, **Arctic flounder**, and **saffron cod** are demersal (i.e., living on or near the seabed) as adults. Distributions are primarily in moderately saline nearshore habitats for much of the year, although all species may migrate for summer feeding into brackish coastal habitats or up rivers. Fourhorn sculpin have been reported more than 50 miles upstream in rivers while Arctic flounder more frequently use lower reaches. Saffron cod normally remain in the zone of tidal influence within rivers.

Pacific herring and **capelin** adults are largely pelagic (i.e., living in open seas). Although most prefer deep-water habitat outside of the barrier islands, both species are captured with some frequency in lagoons and inlets. Additionally, Pacific herring have been found in river deltas.

Arctic cod are considered semipelagic because of their wide distribution throughout demersal and pelagic habitats. They are one of the most abundant fish species found in Arctic coastal waters and frequently travel in large schools. They can be found in a broad range of habitats, including seaward of the barrier islands, lagoons and inlets, and river mouths. They are believed to be the most important consumer of secondary production in the Alaskan Beaufort Sea (Frost and Lowry 1983) and serve as a substantial prey item for marine mammals, birds, and other fishes.

Other species of marine fish may occur in notable numbers within the Coastal Marine Unit at various times, although typically in lesser abundance than the species discussed above. These include, but are not limited to, starry flounder, Pacific sand lance, snailfish species, twohorn sculpin, Canadian eelpout, and slender eelblenny.

3.3.4.4 Commercial Fishing

One small commercial fishery operated in the Colville River Delta east of the NPR-A until 2007 (Gallaway et al. 1989, Fechhelm et al. 2007). This under-ice gill net fishery was operated by the Helmericks family who are long-time local residents. It typically operated from early October through the end of November and concentrated the fishing effort in the Main (Kupigruak) and East Channels of the river near Anachilik Island. The three principal species that were harvested in the fishery are Arctic cisco, least cisco, and humpback whitefish.

At this time, the North Pacific Fishery Management Council's (2009) "Fishery Management Plan for Fish Resources of the Arctic Management Area" has established policy to prohibit commercial fishing in the Arctic until enough information exists to develop a sustainable commercial fishery. The Arctic Management Area includes the portions of the Chukchi and Beaufort seas within the U.S. Exclusive Economic Zone (from 3 nautical miles offshore to 200 nautical miles offshore).

Essential Fish Habitat

The 1996 Sustainable Fisheries Act enacted additional management measures to protect commercially harvested fish species from overfishing. Along with reauthorizing the Magnuson-Stevens Fishery Conservation and Management Act Reauthorization (16 U.S.C. 1801-1882), one of those added measures is to describe, identify, and minimize adverse effects to essential fish habitat. Pacific salmon essential fish habitat consists of some freshwater habitat within the NPR-A, as well as the estuarine habitat along its coast. Portions of Arctic cod and saffron cod essential fish habitat include marine waters in close proximity to the NPR-A coastline. A complete description of Arctic essential fish habitat and relevant background is included in the Essential Fish Habitat Assessment in Appendix D.

3.3.4.5 Fish and Climate Change

There is much uncertainty in projecting future climate change, the potential shifts in physical habitat that may be manifested by climate change, and the biological response to those predicted habitat shifts. Some observed environmental patterns over the last several decades do document currently accelerating trends, such as warming annual mean air temperatures (Shulski, M., data in Martin et al. [2009]), warming winter air temperatures (Osterkamp 2005, 2007), increased snow depths (Stieglitz et al. 2003), permafrost warming and degradation (Romanovsky and Osterkamp 1997, Oechel et al. 2000), and increased thermokarsting and coastal erosion (Mars and Houseknecht 2007). Modeling of future climate conditions (e.g., Scenarios Network for Alaska Planning 2011) is largely based on recent trends such as these; however, the continuation of these trends or the magnitude, should they continue, are both unknown. Furthermore, the Arctic Climate Impact Assessment acknowledges that, due to the major lack of knowledge regarding fish biology and habitat interactions in the Arctic, along with the uncertainty of climate projections, only qualitative scenarios of potential effects on Arctic fishes can be reasonably substantiated (Reist et al. 2006a). From this perspective, the following discussion outlines broad shifts in fish habitat that could possibly occur if modeled future climate trends are relatively accurate.

Modeled future climate trends show increasing mean air temperatures during the winter and summer (Scenarios Network for Alaska Planning 2011), which could drive a multitude of projected physical environmental changes that could have an effect on Arctic aquatic habitats and, subsequently, Arctic fish species. Implicit to warming air temperatures is a warming of water temperatures. Warmer water temperatures alone can increase susceptibility to diseases and parasites (Roberts 1975), increase the effects of contaminants (Schiedek et al. 2007), and decrease biologically available dissolved oxygen (Ficke et al. 2007). Conversely, it can increase biological productivity and fish growth (Mallet et al. 1999, Railsback and Rose 1999), although for each fish species an upper limit would be reached that leads to negative effects (e.g., stress and mortality) due to excessive energetic demands (Magnuson et al. 1979, Tonn 1990). However, the precise effect that warmer water temperatures could have on Arctic fish is complicated beyond these simplified examples since fish largely thermoregulate behaviorally (Beitinger and Fitzpatrick 1979, Ficke et al. 2007), depending on habitat accessibility. Water temperatures can also serve as environmental triggers for life history events, such as gonad maturation and spawning runs, so that a stable increase in water temperatures throughout the year could cause a temporal shift in “population processes” (Reist et al. 2006a). Warmer air temperatures would also lead to a later freeze-up date and an earlier thaw date (Scenarios Network for Alaska Planning 2010), reducing the under-ice overwintering period for fish. Along with fewer freezing degree-days, an associated predicted increase in winter precipitation (Scenarios Network for Alaska Planning 2010) would further contribute to reduced ice thickness via snow insulation (Arp et al. 2010), theoretically increasing the extent of overwintering habitat.

An amplified rate of permafrost melting, in terms of an increasing active layer depth (Scenarios Network for Alaska Planning 2011), is also predicted by modeling. The potential influence of permafrost melting on freshwater habitat could be chemical or physical. A change in water chemistry could be reflected by increased nutrient availability through permafrost degradation (Shaver et al. 1992, Reist et al. 2006b). This could lead to greater algal and invertebrate productivity, which could be transferred to fish (Deegan and Peterson 1992, Peterson et al. 1993). From a physical standpoint, permafrost warming and thermokarst erosion can play a critical role in drainage network response (e.g., channel formation, flow patterns) (McNamara et al. 1999, Lawrence and Slater 2005), which could affect fish habitat extent and accessibility, including drying of migratory corridors resulting from a lower water table.

Further exacerbating the uncertainty of predicting future climate conditions and the potential effect on fish habitats is the fact that the hydrologic cycle is not composed of independent variables. The prominent climate elements that are predicted to change, such as air temperature, precipitation, and potential evapotranspiration (Scenarios Network for Alaska Planning 2011) act collectively to affect waterbodies, with the result being a complicated interaction of factors and feedback loops (Francis et al. 2009, Martin et al. 2009). As a consequence, the future aquatic habitat shifts that may occur are not clear. For example, decadal scale analyses of high-latitude lakes have shown variable results, with lake abundance and surface area decreasing in some areas and increasing in others (Smith et al. 2005, Hinkel et al. 2007, Jones et al. 2009, Marsh et al. 2009). Similarly, the duration and timing of stream-lake connectivity during snowmelt is shown to be shifting in opposing directions in various places in the Arctic (Woo and Guan 2006, Lesack and Marsh 2007).

Even if modeled elements of climate change and predicted shifts in habitat conditions are accurate, the ability to project the ultimate response by individual fish and populations of different species relies on an accurate knowledge of fish biology specific to the region. Many physiological tolerances documented in lower latitudes are applied to northern stocks in analyses, including climate-based modeling of impacts to fish (e.g., McDonald et al. 1996). However, it is known that a species can demonstrate differential preferences that change along a north-south gradient, a result of locally adapting to disparate environmental pressures (Power 1997, Reist et al. 2006). Further inconsistencies are likely a result of determining thermal limits and preferences primarily in laboratories (Mackenzie-Grieve and Post 2006). Not only is there a relative lack of species-specific fish biology knowledge for Arctic populations, but recent studies demonstrate that some widely accepted principals may not be accurate. For example, lake trout have long been believed to be one of the most temperature-sensitive salmonids and, as such, are an especially ideal candidate for monitoring the effects of climate change (Reist et al. 2006b). Historically, it has been widely accepted that the optimal thermal range for both adult and juvenile lake trout is 8-12 °C (Stewart et al. 1983, Mac 1985, Christie and Regier 1988, Magnuson et al. 1990, Edsall and Cleland 2000) and significant physiological stress is expected above 15 °C (Martin and Olver 1980, MacLean et al. 1990). However, recent studies have documented lake trout selecting habitat less than 8 °C even when temperatures considered more optimal are available (Sellers et al. 1998, Mackenzie-Grieve and Post 2006) and also occupying habitat greater than 19 °C (Snucins and Gunn 1995, Sellers et al. 1998, Gunn 2002). Furthermore, lake trout are fundamentally considered to be freshwater obligates with an intolerance of saline waters (Mecklenburg et al. 2002), but current work has demonstrated that an unexpected proportion (27 percent) of lake trout in select northwest Canadian Arctic lakes made annual marine migrations (Swanson et al. 2010). These region-specific studies imply that some fish species may be more plastic than once believed, at least in Arctic regions. Particularly with many Arctic fish having seasonal or annual movements at various scales, fish response to climate change will inevitably reflect integrated impacts across multiple habitats and likely will not be readily apparent (Reist et al. 2006a).

3.3.5 Birds

About 90 bird species including seabirds, loons, waterfowl, shorebirds, raptors, passerines, and ptarmigan are expected to occur annually in the NPR-A or adjacent Beaufort and Chukchi Sea habitats. The vast majority of these species is migratory and present in the planning area only during the summer breeding season (approximately late May through October). A few species, including rock and willow ptarmigan, common raven, gyrfalcon, and snowy owl (Johnson and Herter 1989), occur in the NPR-A year-round.

During the remainder of the year, the migratory species occupy other areas in Alaska, other states, Canada, Russia and other parts of Asia, Mexico and parts of Central America and South America. Because most of the species found in the NPR-A migrate along the Pacific and mid-continent flyways and other major corridors to areas where they spend most of the year, numerous stakeholder groups in Alaska south of the Arctic Coastal Plain, the lower 48 states, and elsewhere, are interested in their conservation and management. These groups include consumptive and nonconsumptive users and wildlife managers. One or more national conservation plans or international agreements signed by the U.S. address most stakeholder interests. These include the Migratory Bird Treaty Act conventions with Mexico, Canada, and Russia, the North American Waterfowl Management Plan, Partners in Flight Bird Conservation Plans, the Arctic Goose, Pacific Coast, and Sea Duck Joint Ventures, U.S. National Shorebird Plan, the North American Colonial Waterbird Plan, North American Bird Conservation Initiative, and the Conservation of Arctic Flora and Fauna.

There have been a number of studies conducted in the last 10 years that have lead to a much greater understanding of the abundance and distribution of shorebirds in the northern portions of the NPR-A. These shorebird studies have also contributed to the understanding of the distribution and abundance of passerines and ptarmigan in the northern portion of the Reserve. Raptors have been studied in the planning area with specifically designed research and monitoring plans targeting the areas of raptor concentrations (e.g., Colville River). The southern portion of the NPR-A has been only studied in a very general manner, and the distribution and abundance of the bird species occurring in this area are primarily known from general ecological surveys or field observations that occurred in the 1960s and 1970s. For some species, distribution and abundance are entirely unknown. This document briefly discusses the population status, distribution, habitat use, and threats to some of the species that are common or occur regularly in the planning area.

3.3.5.1 Seabirds

Ten species of seabirds occur within the NPR-A: glaucous (*Larus hyperboreus*), Sabine's (*Xema sabini*) and Ross's (*Rhodostethia rosea*) gulls, pomarine (*Stercorarius pomarinus*), parasitic (*Stercorarius parasiticus*) and long-tailed (*Stercorarius longicaudus*) jaegers, Arctic tern (*Stern paradisaea*), black guillemot (*Cepphus grille*), horned puffin (*Fratercula corniculata*),and Kittlitz's murrelet (*Brachyramphus brevirostris*) (see section 3.3.8.2, "Special Status Species"). Most seabirds arrive on the Arctic Coastal Plain in early to late May and leave in the September to November time period. Abundance and distribution information regarding seabirds is generally collected by various waterbird surveys (surveys described in the "Waterbirds" section) with the exception of a study of black guillemots on Cooper Island.

Ross's Gull

Ross's gull is an Arctic species with a circumpolar distribution. It breeds primarily in northeast Siberia, with small, scattered colonies in Greenland, Svalbard, and Arctic and sub-Arctic Canada. The global population is estimated at 50,000 breeding adults and appears to be stable[13]. After breeding, Ross's gulls move north into the Arctic Ocean, apparently exploiting drift ice and shelf breaks as far north as there is open water up to the North Pole. From late September to early October, much of the world population of Ross's gull migrates eastward from the Russian Chukchi Sea (20,000 to 40,000 birds [Johnson and Herter 1989]), occupying offshore, near shore, and shoreline habitats from Wainwright to Point Barrow and eastward to the Plover Islands, with highest densities from Point Barrow to Tangent Point (Divoky et al. 1988). These birds make a return westward migration to the Chukchi Sea ending in mid-October. A critical variable influencing breeding attempts in any year is the presence of open water close to the nesting grounds, thus annual ice and snow patterns on the breeding grounds are likely the major limiting factor to reproduction[14]. As an obligate Arctic-adapted species, climate change represents an unknown potential effect on the reproductive ecology of Ross's gull.

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[13] http://www.sararegistry.gc.ca/document/dspText_e.cfm?ocid=5423; accessed October 20, 2010

Glaucous Gull

Glaucous gulls are common migrants and breeders in the NPR-A. Glaucous gulls winter along the Pacific Coast from the Aleutian Islands to California and along the Atlantic Coast from Labrador and Greenland south to the eastern United States. Birds from the NPR-A that were tracked using satellite telemetry were found to winter along the Pacific Coast of Russia and Asia and none wintered in North America (Troy 2007). They nest primarily in coastal areas, but are known to nest throughout the Reserve. In the southern portions of the planning area, they primarily nest in association with river systems and on small islands in lakes (Gilchrist 2001). At their NPR-A study site in the northern portion of the planning area, Johnson et al. (2005) found most glaucous gull nests on islands or on complex shorelines of eight different habitats. In the more northerly and coastal portions of the planning area, they are found in high densities near Wainwright, Barrow, Atqasuk, and at the south end of Admiralty Bay, with lower numbers along the coast north of Teshekpuk Lake (Larned et al. 2011) (see Map 3.3.5-1). The 2010 glaucous gull population index on the Arctic Coastal Plain was 12,064 and has remained essentially level and stable in the short and long terms. Multi-year studies of glaucous gulls equipped with satellite transmitters from the northern portion of the NPR-A have provided detailed insights into migration routes, wintering and breeding locations, and home range sizes (Troy 2007, 2010). During fall migration, glaucous gulls moved away from the planning area beginning in October, and were later located in a band from northern Alaska to the Sea of Okhotsk, primarily south of the Bering Strait. During winter the gulls were found near the Kamchatka Peninsula and in the Sea of Okhotsk. The vast majority of spring migration takes place in May with much of the movement taking place overland as opposed to coastally. Breeding birds were found to have very small core use areas, but large home ranges, indicating that birds remained very close to their nests the majority of the nesting and chick-rearing periods.

Oil field development has introduced many concerns pertaining to potential adverse effects on birds. The National Research Council (2003) concluded that oil and gas development on the North Slope of Alaska has lead to an increased number of predators and consequently decreased reproductive success of many birds. There is widespread suspicion that glaucous gull abundance has/will increased due to the availability of waste human food and that this has/will lead to increased predation on a variety of nesting birds (Day 1989). Many North Slope residents believe that the glaucous gull population on the North Slope has increased in the past 20 years. Noel et al. (2006) determined that it is not clear that glaucous gulls are becoming more abundant on the Arctic Coastal Plain, but there are indications that human populations may influence the patterns of glaucous gull coastal distribution. The National Research Council (2003) reports that glaucous gull populations are increasing across the Arctic; however, they state that it is not clear whether the increases in the oil fields are part of a global pattern or associated with local changes caused by oil development. Day (1998) cites numerous accounts of foraging by glaucous gulls in North Slope landfills, including those in oil fields. The two multi-year telemetry studies mentioned above also provided insights and comparison into a study of the use of anthropogenic food sources by the gulls (Weiser and Powell 2010). Weiser and Powell (2010) conducted a study of glaucous gull diet on the Arctic Coastal Plain using both pellet and isotope analysis. Weiser and Powell (2010) determined that gulls breeding near Deadhorse were obtaining a large portion of their diet from anthropogenic sources while gulls from the other sites (Alpine, Barrow) were using largely natural food sources. Telemetry studies (Troy 2007) indicate that few of the gulls nesting near Alpine visited the landfill at Nuiqsut. Although Weiser and Powell (2010) found the gulls nesting near Deadhorse obtained considerable anthropogenic food, the telemetry data suggest that the Prudhoe Bay landfill was not the source. The breeding birds that were outfitted with transmitters in Deadhorse did not visit the landfill, but did include much of Deadhorse in their home ranges indicating scavenging in the town (parking lots, beds of pickups, dumpsters) (Troy 2007, 2010). Concerns about increased predator numbers have prompted changes in waste management practices, resulting in implementation of intermittent gull control programs near Barrow, and through stipulations attached to BLM leaseholds permits for oil and gas exploration activities.

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[14] http://www.механ sararegistry.gc.ca/document/dspText_e.cfm?ocid=5263; accessed October 20, 2010

Sabine's Gull

Breeding Sabine's gulls are found across the Arctic Coastal Plain from the vicinity of Cape Sabine east to Demarcation Bay, including (rarely) offshore barrier islands (Johnson and Herter 1989). They are also seen inland, but do not breed, at the northern edge of the Foothills Province (Gabrielson and Lincoln 1959, Derksen et al. 1981). Sabine's gulls are found in the northern part of the NPR-A and are most numerous in the upper reaches of the Inaru, Topagourk, and Ikpikpuk rivers and along Fish and Inigok creeks (Larned et al. 2011) (see Map 3.3.5-2). The 2010 Sabine's gull population index (10,338 birds) and has remained essentially level and stable in both short and long terms (Larned et al. 2011). In the planning area, Sabine's gull nests primarily in drained lake-basins containing extensive wetlands intermixing ponds, lakes, marshes, islets, and peninsulas. Sabine's gulls winter at-sea off the west coasts of Africa and South America (Day et al. 2001). As an obligate Arctic-adapted species, climate change represents an unknown potential effect on the reproductive ecology of Sabine's gull.

Arctic Tern

The arctic tern is a fairly common breeder and migrant in the northern portion of the NPR-A. It is most commonly found near the coast, but may also nest inland on gravel bars, marshes, bogs, and grassy meadows (Hatch 2002, Johnson and Herter 1989). The 2010 population index (12,188 birds) indicates a slightly increasing population in the long term (Larned et al. 2011) (see Map 3.3.5-3). Johnson et al. (2007) found arctic terns using both polygon complexes and sedge marsh for nesting at their two study areas in the northern portion of the NPR-A. Arctic terns winter in the sub-Antarctic and Antarctic waters of the Pacific, Atlantic, and Antarctic oceans (Hatch 2002). Arctic terns forage by plunge diving and surface dipping for a wide variety of small fish, crustaceans, and other invertebrates, and also hawk for flying insects. In some locations, aquatic insects are the principal prey. Threats to arctic tern populations include potential changes in timing of prey availability due to climate change and oil or other toxic spills in both the breeding and wintering areas. The U.S. Fish and Wildlife Service has placed the arctic tern on the Birds of Conservation Concern list for the Arctic Plains and Mountains Bird Conservation Region.

Black Guillemot

Black guillemots are a colonial breeder. The only known colony within the planning area is located on Cooper Island within the Plover Islands off Point Barrow (Divoky et al. 1974) (see Map 3.3.5-4). This colony was discovered in 1972 and has been monitored yearly since 1975. Black guillemot colonies are frequently limited by the availability of suitable nest sites. On Cooper Island, artificial cavities (nest sites) were constructed from 1975 through the mid-1980s. The colony increased from18 pairs in 1975 to over 200 pairs in 1989, making it the largest black guillemot colony in Alaska at that time. Colony size began to decrease shortly afterward, with a decline of almost 100 pairs by the mid 1990s. In the early part of the study, the breeding population size was determined by the number of available nest sites, but now is apparently limited by prey availability. Guillemots forage near their colonies from June to early September. Beginning in 1990 there has been increased warming in the western Arctic with higher air temperatures and decreases in pack ice extent (Maslanik et al. 1996, 1999). Black guillemots in the western Arctic undertake limited migrations, wintering no further south than the pack ice in the central Bering Sea and apparently as far north as open water is present. Because ice cover is rarely complete, diving species such as the black guillemot can exploit cracks and other openings in the ice to access food resources in the waters beneath the ice. Most importantly perhaps, the underside of Arctic Sea ice supports a community of fish and zooplankton that feed on phytoplankton and algae blooms that occur within and on the undersurface of ice. This under-ice fauna provides a prey source associated with a substrate that is similar to the nearshore benthic communities that guillemots rely on elsewhere. Threats to the black guillemont population include changes in prey availability due to climate change, increased polar bear predation on nestlings, competition with horned puffins, and potential oil or other toxic spills.

3.3.5.2 Jaegers

All three species of jaegers spend winter at sea, but migrate to tundra breeding grounds during the summer. Larned et al. (2010) report that numbers of jaegers (all species combined) counted on surveys across the Arctic Coastal Plain fluctuate widely, following cycles of microtine prey abundance. They also note that the jaeger population index spiked upward across much of the Arctic Coastal Plain in 2006, but since has returned to a number close to the long-term mean of 4,131 birds. The 2010 jaeger index (3,690 birds) indicates a continuation of a stable long-term population index (Larned et al. 2011). Researchers at various study sites throughout NPR-A have collected local scale data on jaegers occurring within their study areas.

Pomarine Jaeger

The pomarine jaeger is a holarctic breeder. In northern Alaska, it breeds primarily on the coastal tundra, including the NPR-A (Johnson and Herter 1989). Johnson and Herter (1989) consider pomarine jaeger to be a common migrant and an uncommon breeder in the Beaufort Sea area. Their tundra-breeding habitat includes marshes, wet polygonal tundra, well-drained tundra, and marshy swales between low ridges (Wiley and Lee 2000). During winter, they occupy pelagic habitats in tropical and subtropical environments. No estimates of population size or trends are available for any area in the nearctic (but see “Jaegers” section above). Pomarine jaegers are dependent on a single species of prey, the brown lemming (*Lemmus trimucronatus*), for successful reproduction. Densities of breeding birds vary with the densities of lemmings. When lemmings are scarce, nearly all birds leave without breeding, whereas in years with abundant lemmings, they nest in large numbers (Wiley and Lee 2000). Liebezeit and Zack (2005, 2006, 2007, 2008) provide evidence of changes in breeding behavior lemming varying densities with the results of their studies near Teshekpuk Lake and the Prudhoe Bay oil field, showing a clear positive relationship between the number of lemmings and the number of pomarine jaegers present. The only area for which there is data on pomarine jaeger population densities over an entire cycle of lemmings is near Barrow and that study also produces the same conclusion of greater pomarine jaeger density with greater densities of lemmings (Pitelka et al. 1955a, Maher 1970, 1974). The Barrow area is known to support higher densities of pomarine jaegers than anywhere else in the nearctic, with 7 to 10 pairs/square kilometer in high lemming years (Pitelka et al. 1955b, Maher 1970 and 1974, Wiley and Lee 2000). Derksen et al. (1981) found pomarine jaegers to be migrants or casual visitors to their study sites in the central portion of the NPR-A and migrants occur in small numbers inland at least as far as the foothills along the Colville River (Kessel and Cade 1958). Pomarine jaeger populations are vulnerable to any changes in the frequency and magnitude of the lemming cycle (changes may occur due to climate change) as they depend exclusively on lemmings for food during the breeding season. Any changes in the supply of winter forage due to climate change in the oceans have the potential to affect pomarine jaegers.

Parasitic Jaeger

The parasitic jaeger is a holarctic breeder. In Alaska, it breeds primarily on the coastal tundra along the Arctic (including the NPR-A) and west coasts, the Alaska Peninsula, and throughout the Aleutians (Johnson and Herter 1989, Wiley and Lee 1999). They occupy widely distributed wintering areas off both coasts of South America. Johnson and Herter (1989) consider it to be a common to uncommon migrant and breeder in the Beaufort Sea area and an occasional breeder at Barrow. No estimates of population size or trends are available for any area in the nearctic (but see “Jaegers” section above). Parasitic jaegers are predators on small birds and eggs of many species of nesting birds including waterfowl (Wiley and Lee 1999). Due to this ability to use a diverse guild of prey species, the reproductive success of parasitic jaegers is not as vulnerable to fluctuations in prey species as is that of pomarine and long-tail jaegers. Very low densities of breeding parasitic jaegers are found in the NPR-A with estimates of less than one bird/square kilometer across the planning area being common (Andersson 1973, Maher 1974, Johnson and Herter 1989, Derksen et al. 1981). Any changes in the supply of winter forage due to climate change in the oceans have the potential to affect parasitic jaegers.

Long-tailed Jaeger

The long-tailed jaeger is a holarctic breeder which in Alaska breeds primarily in passes, valleys, and foothills of the Brooks Range extending 50 to 150 kilometers to the north. In winter, they occupy pelagic habitats off the Atlantic and Pacific coast and are most common off the shores of Argentina and Chile (Johnson and Herter 1989). Johnson and Herter (1989) consider long-tailed jaeger to be a common migrant and an uncommon breeder in the Beaufort Sea area. It is not considered a regular breeder in the NPR-A (Pitelka et al. 1955a, Maher 1974, Sage 1974, Derksen et al. 1981). No estimates of population size or trends are available for any area in the nearctic (but see “Jaegers” section above). The diet of long-tailed jaegers is composed primarily of five species of lemmings and voles, making its reproductive output vulnerable to the cycles of its prey species although these cycles are likely less drastic then the cycles of the brown lemming on the coastal plain (Wiley and Lee 1998). In the NPR-A, densities of breeding pairs tend to be less than one pair/square kilometer (Derksen et al. 1981, Maher 1974, Williamson et al. 1966, Liebezeit and Zack 2006, 2007, 2008). Long-tailed jaeger populations are vulnerable to any changes in the frequency and magnitude of the cycles of their primary prey sources during the breeding season (changes may occur due to climate change). Any changes in the supply of winter forage due to climate change in the oceans have the potential to affect long-tailed jaegers.

3.3.5.3 Waterbirds

The majority of the broad scale information that exists for waterbirds (geese, ducks, swans, and loons) on the Arctic Coastal Plain has been collected by the U.S. Fish and Wildlife Service using a combination of surveys designed to address differences in timing and spatial distribution of different waterbirds (Larned et al. 2010, Mallek 2011, Dau and Bollinger 2009). Other surveys designed for optimal data collection of waterbirds include the "Barrow Triangle" aerial survey for Steller's eiders and snow geese colony surveys on the Ikpikpuk River delta, and brant colony surveys.

3.3.5.4 Loons

Pacific, red-throated, and yellow-billed loons breed across the NPR-A. Loons arrive in late May and establish breeding territories on tundra lakes and ponds as soon as the margins of these habitats are free of ice and snow. Earnst (2004) indicates that loons may stage in river deltas in the spring while waiting for onshore habitats to become available. After nesting, loons may move to marine habitats before migration in August and September (Johnson and Herter 1989). The yellow-billed loon has been assigned candidate status by the U.S. Fish and Wildlife Service and sensitive status by the BLM; therefore, it is addressed in section 3.3.8.2, "Special Status Species." Yellow-billed and red-throated loons have both been identified on the U.S. Fish and Wildlife Service's Birds of Conservation Concern list for the Arctic Plains and Mountains Bird Conservation Region.

Red-throated Loon

The red-throated loon has a circumpolar distribution and breeds in and near coastal areas throughout Alaska. Generally, it is much more numerous in the Alaskan tundra than in other parts of Alaska (Groves 1996). Red-throated loons marked with satellite transmitters on the Arctic Coastal Plain in 2008 and 2009 migrated through the Chukchi Sea to wintering areas primarily located in Asia. Two of 12 tagged loons, however, remained on the west coast of North America (Rizzolo and Schmutz 2009). All three adult loons marked in 2008 returned to nesting grounds on the Arctic Coastal Plain in 2009 (Rizzolo and Schmutz 2009). All juvenile birds marked in 2008 migrated toward wintering grounds in Asia in the fall; one individual remained in the area of the western Kuril Islands through both winter and summer, providing the first information on the year-round movements of a juvenile red-throated loon (Rizzolo and Schmutz 2009). The 2010 red-throated loon population index (1,578 birds) reflects a decrease from the mean population index of 2,525 birds (Larned et al. 2011). Long-term data from the U.S. Fish and Wildlife Service aerial survey area shows a significant negative trend for this species in both the long term and over the last 10 years (Larned et al. 2011). Groves et al. (1996) determined that the overall

Alaska population of red-throated loons declined by 53 percent since the 1970s within a study area encompassing the Arctic Coastal Plain, the Yukon-Kuskokwim rivers delta, coastal Bristol Bay, and various locations in the interior, with most of the decline in western tundra areas (McCaffery 1998). Along the coast, red-throated loons occur in relatively high densities both east and west of Dease Inlet and north of Wainwright, while further inland they are associated with river floodplains between the Meade, Topagoruk, and Ikpikpuk rivers (Larned et al. 2011) (see Map 3.3.5-5). Red-throated loons occur in low numbers in the southern portions of the NPR-A (Irving and Paneak 1958, King 1979, Reed 1956). Red-throated loons are the only loon in the planning area that forage and provision their young from marine environments away from the nest lake (Barr et al. 2000, Eberl and Picman 1993).

Threats to red-throated loon populations include contaminants (including oil), and any changes to the forage fish populations that might occur from climate change. Environmental contaminants are a threat to red-throated loons as shown by a study of eggs from four nesting areas in Alaska. Eggs from the Arctic Coastal Plain had greater polychlorinated biphenyl (PCB) toxicity than eggs from the other sites. This suggests that red-throated loons breeding in northern Alaska are exposed to PCBs while on their Asian wintering grounds as body reserves used to produce eggs are acquired during the winter. Predation of eggs and young may increase if industrial and community development provide opportunities for increases in predator populations on the nesting grounds.

Pacific Loon

The Pacific loon is the most abundant loon species found across the North Slope of Alaska (Johnson and Herter 1989). Pacific loons winter mainly on the Pacific Coast from southeastern Alaska to south Mexico (Johnson and Herter 1989). Although the 2010 Pacific loon population index (15,362 birds) is the second lowest index value recorded for the survey, the long- and short-term population index trends are stable (Larned et al., in preparation). Pacific loons are wide spread in relatively high densities throughout the northern half of the planning area, with notable concentrations between Wainwright and the Topagoruk River, between Barrow and Atqasuk, and southeast of Teshekpuk Lake (Larned et al. 2011) (see Map 3.3.5-6). Many researchers (including Maher 1959, Reed 1956, Russell 2002, Sage 1974) have reported the presence and breeding of Pacific loons in the southern portion of the NPR-A, but there are no records of distribution or abundance from that area available for this species. Pacific loons use freshwater lakes and wetlands on sub-Arctic and Arctic tundra and taiga for breeding (Bergman et al. 1977, Derksen et al. 1981, Russell 2002). Pacific loons exhibit site fidelity to breeding locations, often returning to the same lake or pond in successive years (Kertell 2000). Threats to Pacific loon populations include oil or other toxic spills on their wintering and/or breeding grounds and any changes to the forage fish populations on the wintering or breeding grounds due to climate change or El Niño events (Quinn et al. 1987). Predation of eggs and young may increase if industrial and community development provide opportunities for increases in predator populations on the nesting grounds.

3.3.5.5 Waterfowl

At least 20 species of waterfowl (ducks, geese, and swans) breed within the NPR-A. With exception of the eiders, most of them migrate to NPR-A from wintering grounds located primarily in Canada, the contiguous U.S., and Mexico. Fifteen duck species regularly occur on the Arctic Coastal Plain (Mallek et al. 2006). The two most common species are northern pintail and long-tailed duck, which together comprise about 85 percent of the total Arctic Coastal Plain duck population. Other species, including all four eider species, occur in much lower densities. Steller's and spectacled eiders are listed as threatened under the Endangered Species Act (ESA) and are addressed in section 3.3.8.2, "Special Status Species."

Wetland habitat use varies among the waterfowl, but appears to be strongly related to the abundant food associated with emergent vegetation in aquatic habitats (Derksen et al. 1981, Gilliam and Lent 1982). Within NPR-A the most preferred habitat types for waterfowl include shallow wetlands, deep lakes, beaded streams, and deep open lakes (Derksen et al. 1981, Johnson et al. 2005).

Tundra Swan

Tundra swans (*Cygnus columbianus*) breed in the Arctic from the Aleutian Islands, through coastal western Alaska, and across the northern tundra regions of Alaska and Canada (Limpert and Earnst 1994). There are two separate wintering populations, with swans breeding south of Point Hope migrating to the Pacific Coast between Vancouver Island and California, and those breeding east of Point Hope migrating to the Atlantic Coast (Limpert and Earnst 1994). Most tundra swans nesting in the Beaufort Sea area probably winter along the Atlantic Coast, principally from New Jersey to South Carolina (Limpert and Earnst 1994). In the NPR-A, tundra swans are common on both the east and west sides of Dease Inlet and Admiralty Bay, and concentrations also occur southwest of Nuiqsut between Judy Creek and the Tingmiaksiqvik (Ublutuoch) River, and east and west of Teshekpuk Lake (see Map 3.3.5-7). Substantial numbers of tundra swans stage in late summer just west of Teshekpuk Lake (North Slope Borough, unpublished data). Interim habitat is provided in the headwaters of the Anaktuvuk, Colville, Killik, Nigu, Etivluk, Nuka, Utukok and Kokolik rivers in years when persistent ice delays movement onto nesting grounds (King 1979).

The 2010 tundra swan index (10,012 birds) is the third of three consecutive highest indices in the history of the survey (Larned et al. 2011). Tundra swan indices indicate a significant positive growth rate (Larned et al. 2011). Tundra swans are thought to breed in low densities (no more than 0.1 per square mile) in the southern portion of the NPR-A (King 1979).

While swans use a variety of aquatic habitats for nesting, the most important appear to be deeper *Arctophila* wetlands (Derksen et al. 1981, Limpert and Earnst 1994). The *Arctophila* and *Carex* wetlands and deeper open lakes appear to be the most important brood-rearing habitats for this species. Fall-staging flocks of 350 to over 400 have been observed (Johnson et al. 1996). Threats to this species include loss of wetlands at migratory stopover sites, changes in breeding habitat due to effects of climate change, and potential negative effects from oil and gas exploration and drilling (e.g., loss of habitat, disturbance) including potential increases in predation of eggs and young if industrial and community development provide opportunities for increases in predator populations on the nesting grounds.

Black Brant

The breeding range of the black brant (*Branta bernicla*) extends from the low Arctic to the very high Arctic, mainly in Alaska and the Northwest Territories of Canada (Limpert and Earnst 1994). Brant that use the planning area winter along the Pacific Coast from Alaska south to the coast of Mexico (Limpert and Earnst 1994). Some birds also winter along the Asian Coast, from Japan to southern China (Bellrose 1976). Brant nest in both small and large colonies that are used year after year; these colonies generally are near the coast, but may be 18 miles or more inland (Derksen et al. 1981; Reed et al. 1998) (see Map 3.3.5-8). Although the NPR-A supports breeding brant, it is especially important as a post-breeding, pre-migration molting area for brant and other goose species. Fall-staging flocks of brant concentrate in Beaufort Sea lagoons, bays, and deltas (Derksen et al. 1982), and large numbers also stage in Kasegaluk Lagoon on the Chukchi Sea Coast (Johnson 1993) where they feed on the abundant algal vegetation. The largest known concentration of molting and brood-rearing brant on the Arctic Coastal Plain occurs in the north and northeast Teshekpuk Lake (Derksen et al. 1982) (see Map 3.3.5-9). As many as 30 percent of the Pacific flyway population of brant may be present in the Teshekpuk Lake goose molting area during the molting period. Many of these molting birds are failed breeders and non-breeders that have migrated from breeding colonies in western Alaska, Canada, and Siberia, arriving in the NPR-A in late June and early July to molt (Bollinger and Derksen 1996). The origin of this molt-migrant population from such distant nesting areas emphasizes the international importance of the Teshekpuk Lake area to molting brant as well as other goose species. Black brant are valued by subsistence users in northern and western Alaska as well as sport hunters along the West Coast and in Mexico.

Three surveys conducted yearly in the NPR-A provide estimates and trends of the breeding and molting population of brant. The annual waterfowl breeding pair survey conducted by the U.S. Fish and Wildlife Service records all brant sightings, but due to their colonial nesting habits brant are difficult to detect with the systematic design employed by this survey. Results of this survey suggest a significant positive growth trend in the black brant breeding population, or more precisely, an abrupt increase between 2002 and 2005, with subsequent stability through 2010 (Larned et al., in preparation).

Since 1996, the North Slope Borough Department of Wildlife Management has contracted with ABR, Inc. to conduct annual aerial surveys in June of selected black brant nesting colonies between Barrow and Fish Creek, spanning the main nesting area for brant in the planning area (see Map 3.3.5-8). Since 1995 (excluding 1998), annual aerial surveys of brood-rearing brant have been conducted in the same area during July. The total number of brant nests among the 23 monitored colonies have increased since surveys began in 1996 (Ritchie et al. 2010). In 2009, the nesting surveys recorded a minimum of 373 nests at 20 occupied colonies (Ritchie et al. 2010). A comparison of these numbers with estimates collected at the same colonies in previous years show that nest numbers decreased 12 percent from 2008, but were still about 30 percent higher than the 15-year average of 289 nests. During brood-rearing surveys in 2009, ABR, Inc. estimated 21,365 brant in 161 groups. This estimate was comprised of 18,404 adults in groups without broods, 2,380 adults in groups with broods, and 581 goslings (Ritchie et al. 2010). The number of adult birds was the highest recorded, and the number of groups was the second-highest recorded, since surveys began in 1995 (Ritchie et al. 2010). In 2009, only 13 percent of all brant groups were brood-rearing groups, the lowest percentage ever recorded and substantially lower than the mean of 43 percent brood-rearing groups over all 14 years of surveys. Goslings comprised 20 percent of the total brood-rearing brant counted in 2009, well below the annual mean of 35 percent and the lowest on record (Ritchie et al. 2010). Although the brant brood-rearing data suggest that the breeding population and productivity has been increasing, the increase has primarily been due to an increase in the number of adults in groups without broods, indicating that the increase in numbers may be a product of an increase in birds using the NPR-A for molting.

The final survey for brant in the planning area is conducted by the U.S. Fish and Wildlife Service (Teshekpuk Lake goose molting survey Map 3.3.5-9). This effort has been annual since 1976, with the exception of 3 years (1979–1981). In 2009, 18,647 brant were counted in the study area, accounting for approximately 12 percent of the total 2007–2008 Pacific flyway (Mallek and Wortham, 2008). The total count was similar to the previous 10-year (1999–2008) mean of 19,124 (Mallek 2009). Given a number of brant breeding behavioral reasons, Mallek (2009) states that "while these numbers are useful indicators of the importance of this area to brant, they cannot be used to estimate the proportion of the Pacific flyway population that uses this area in their life cycle."

A recent (2006–08) study conducted by the USGS has shown that populations of all species of molting geese in the Teshekpuk Lake Special Area have changed in abundance and spatial distribution over the past 30 years (Flint et al. 2007). Flint et el. (2007) found brant to be relatively stable in numbers, but are shifting distribution from large, inland lakes to salt marshes. Concurrently, populations of greater white-fronted geese have increased seven fold while populations of Canada geese are stable with little indication of distributional shifts. The lesser snow goose population is proportionally small, but increasing rapidly. The area with the highest rate of population increase for greater white-fronted geese corresponds with the area where brant populations are declining most rapidly (Flint et al. 2007). Beginning in 1976, molting brant have changed their distribution within the Teshekpuk Lake Special Area, redistributing from inland, freshwater lakes towards coastal, brackish wetlands (Lewis et al. 2010). Lewis et al. (2009) noted interesting patterns during their study on brant movements and habitat use. During the pre-molt period, they found that brant did not generally migrate directly to their molting sites. Instead, the birds visited multiple wetlands prior to settling on their primary molt wetland, with the majority having visited and departed their ultimate molt location before returning to molt. Brant spent significant time in both inland and coastal habitats during the pre-molt, irrespective of the habitat in which they ultimately molted (Map 3.3.5-10). During the flightless period, they used a large amount of habitat that was located almost exclusively close to the shoreline of lakes and wetlands. After the flightless period, the spatial and temporal movements of individual brant depended on the habitat in which they molted. Individuals that molted in inland habitats very quickly left the area and moved to coastal habitats, while those that molted in coastal areas remained, resulting in coastal wetlands that were occupied by large flocks (more than 10,000 birds) of flight-capable birds. This indicates that coastal wetlands were preferred by brant as they completed the molt period (Lewis et al. 2009).

The final portion of the USGS study investigated the results of repeated aerial surveys in the study area. Molting populations totaling 18,000 and 23,000 brant were counted in 2007 and 2008, respectively, with significant numbers of birds present in the Teshekpuk Lake Special Area from early July through mid-August of each year, and the majority of the population was found along the coast, primarily near Garry Creek and the Smith River (Lewis et al. 2009) (see Maps 3.3.5-11 and 3.3.5-12).

Changes in the climate of the Arctic in recent decades have lead to landscape-level ecological changes (Overpeck et al. 1997, Sturm et al. 2001). Coastline erosion of the Beaufort Sea has altered tundra habitats by allowing saltwater intrusion, which has resulted in shifts in composition of forage plant species which may have lead to changes in the types of habitats available to geese molting in the NPR-A. Threats to this species include overgrazing of critical salt marsh habitat by increasing numbers of snow geese, loss of wetlands at migratory stopover sites, changes in breeding habitat due to effects of climate change, and potential negative effects from oil and gas exploration and drilling (e.g., loss of habitat, disturbance) including potential increases in predation of eggs and young if industrial and community development provide opportunities for increases in predator populations on the nesting grounds.

Greater White-fronted Goose

In Alaska, greater white-fronted geese (*Anser albifrons*) breed across the Arctic Coastal Plain, from Barrow south to Yukon-Kuskokwim rivers delta and in all of interior Alaska east of Yukon-Kuskokwim rivers delta and north of Alaska Range (Ely and Dzubin 1994). White-fronted geese from the Arctic Coastal Plain winter along the coasts of Texas and Louisiana, and in Mexico. White-fronted geese are important to both subsistence and sport hunters, not only in Alaska, but also in other states and countries, such as Canada, Russia, and Mexico. The 2010 greater white-fronted goose population index of 146,828 birds is the fourth of four consecutive highest indices in the history of the survey, exceeding the 17-year mean by 61 percent (Larned et al. 2011).

The population trends are significantly positive (increasing) in both the long and recent 10-year periods (Larned et al. 2011). The largest concentrations of white-fronted geese in the NPR-A occur to the north, east, and west of Teshekpuk Lake, south of Admiralty Bay, southwest of Smith Bay, southeast and south of Peard Bay (Larned et al. 2011) (see Map 3.3.5-13). The 2009 U.S. Fish and Wildlife Service molting goose count for adult white-fronted geese was 34,944 birds, while the gosling count was 4,249, accounting for 44 percent of all adult geese of all species observed on the survey (Mallek 2009). The 2009 count of white-fronted geese on the molting geese survey illustrates the continuing positive annual growth of 1.13 during the molt period. Analysis of goose population trends in the Teshekpuk Lake Special Area conducted by the USGS shows that greater white-fronted goose populations increased geometrically between 1976 and 2005 (Lewis et al. 2009). Greater white-fronted geese generally nest in small, loose colonies farther inland than brant. Preferred nesting habitat includes elevated sites near shallow wetlands. Beaded streams are a favored habitat for pairs and pairs with broods (Derksen et al. 1981, Johnson et al. 1996). Studies in the Teshekpuk Lake area indicate that post-breeding birds favor deep, open lakes during the molt. Unlike brant and Canada geese, greater white-fronted geese do not shift their distribution to coastal areas following molt (Derksen et al. 1981). Derksen et al. (1981) found greater white-fronted geese nesting and molting as far south as Singiluk in central NPR-A south-southeast of Atqasuk (see Map 3.3.5-4). Johnson et al. (2005) analyzed 5 years of data collected from nest surveys in the CD-3 area of the Alpine oil field and found that the two most frequently used habitats for nesting are: patterned wet meadow (39 percent of nests) and deep polygon complex (28 percent). Most groups of brood-rearing white-fronted geese observed in the CD-3 search area were located in patterned wet meadow.

Changes in the climate of the Arctic in recent decades have lead to landscape level ecological changes (Overpeck et al. 1997, Serreze et al. 2000, Sturm et al. 2001, Jorgensen et al. 2006). Coastline erosion of the Beaufort Sea has altered tundra habitats by allowing saltwater intrusion, which has resulted in shifts in composition of forage plant species, which may have lead to changes in the types of habitats available to geese molting in the Reserve. Threats to this species include loss of wetlands at migratory stopover sites, changes in breeding habitat due to effects of climate change, and potential negative effects from oil and gas exploration and drilling (e.g., loss of habitat, disturbance) including potential increases in predation of eggs and young if industrial and community development provide opportunities for increases in predator populations on the nesting grounds.

Lesser Snow Goose

Lesser snow goose (*Chen caerulescens*) nest primarily in Arctic Canada and Russia, although there are several small and one rapidly growing colony (Ikpikpuk River delta colony) nesting along the coastline and river deltas of the NPR-A (Ritchie et al. 2010). Snow geese from the Ikpikpuk colony likely winter in California and Mexico and along the Central and Mississippi flyways (Ritchie et al. 2010). Within the NPR-A the largest population of snow geese occurs on the islands of the Ikpikpuk River delta (see Map 3.3.5-14). Between 1992 and 2009, the number of adult snow geese at the Ikpikpuk colony increased from 200 to 9,374, with a high count of 14,398 adults using the colony in 2008 (Ritchie et al. 2010). The number of nests at the Ikpikpuk colony also increased, from 60 in 1992 to 4,479 in 2009, with a high count of 4,641 in 2008 (Ritchie et al. 2010). Nesting success of snow geese at the Ikpikpuk colony has increased from 7 percent in 1992 to 89 percent in 2008; in 2009, there was almost complete nesting failure on the colony due to brown bears destroying the vast majority of nests prior to hatch (Ritchie et al. 2010).

Brood-rearing surveys in the planning area detected 142 molting groups and 20 brood-rearing groups of snow geese between Barrow and Fish Creek in 2009 (Ritchie et al. 2010). A total of 15,271 snow geese were counted during these surveys in 2009, the third-highest number ever recorded. During 2009, most snow geese (79 percent) detected during the brood-rearing survey were located in the Smith Bay area, most of the remaining snow geese were found in the Harrison Bay area, with approximately 0.5 percent in the Dease Inlet area (Ritchie et al. 2010) (see Map 3.3.5-15). A rapid increase of snow geese in the NPR-A has also been documented by the surveys conducted by the U.S. Fish and Wildlife Service during the Teshekpuk Lake molting goose surveys (Mallek 2009). Numbers of molting snow geese detected during that survey first exceeded 500 geese in 1997, and by 2001, more than 2,000 birds were counted (Mallek 2009). By 2006, there were 4,000 snow geese counted, and the count exceeded 6,000 in 2007 and 2009 (Mallek 2009). It is unknown if these large numbers of molting snow geese are associated with the local breeding colonies and failed local breeders, or if non-breeding snow geese migrate into the Teshekpuk area from colonies farther afield (as demonstrated for brant). There are other small colonies of snow geese scattered across the NPR-A including those located between Cape Halkett and Fish Creek, at the mouths of the Kogru River and Garry Creek, and one on the Kukpowruk River delta. Derksen et al. (1981) and Bergman et al. (1977) found very few snow geese on their study areas during the 1970s. Johnson et al. (2005) have found small numbers of snow geese nesting in scattered locations on the Colville River delta.

Threats to snow geese include effects of their own increasing populations, which may lead to over grazing of salt marsh habitat, which is a critical food resource for both snow geese and brant during brood rearing. Climate change may result in changes to the nesting and feeding habitats with unknown impacts to the snow goose population. Oil and gas development in area were snow geese are nesting, molting, and raising young may cause negative impacts through habitat loss, disturbance, and potential increases in predation of eggs and young if industrial and community development provide opportunities for increases in predator populations on the nesting grounds.

Canada Goose

Canada geese (*Branta canadensi*) nest in Alaska from the Seward Peninsula and Kotzebue Sound, north along the western Alaskan Arctic Coast and across the Arctic Coastal Plain (Mowbray et al. 2000). After breeding, individuals from northern breeding areas generally travel relatively long distances from Arctic and sub-Arctic areas of Alaska to various wintering locations in the mid-latitude and southern areas of the U.S. (Mowbray et al. 2000). There has been a general increase in the number of Canada geese in North America since the 1940s to approximately 5 million in 2000 (Mowbray et al. 2000).

The Canada goose nests in low densities in the NPR-A. It is a much more common breeder in the interior of Alaska than on the Arctic Coastal Plain. After nesting, small flocks of interior-nesting Canada geese migrate to the Arctic Coastal Plain where they aggregate with locally nesting geese to molt. The 2010 Canada goose Arctic Coastal Plain population index was 12,676 birds, which is 52 percent above the long-term mean (Larned et al. 2011). Canada geese were most prevalent near the coast north of Teshekpuk Lake, although they have been detected in lower densities, scattered inland throughout the central portions of the survey area (Larned et al. 2011) (see Map 3.3.5-16). The 2009 Canada geese count during the annual U.S. Fish and Wildlife Service goose molting survey in the Teshekpuk Lake area was 18,720 birds, which is well above the previous 10-year (1999–2008) mean of 12,235 birds (Mallek 2009). Johnson et al. (2005) located 34 Canada geese nests, primarily in aquatic or wetland basin habitats, in their study area in the northeast portion of the planning area. Johnson et al. (2005) found very few brood-rearing Canada geese in their study areas within the NPR-A. In the southern portion of the Reserve, Canada geese have been found nesting along the Colville River on cliffs, bluffs, and steep talus slopes, often in nests built by common ravens or rough-legged hawks (Kessel and Cade 1958, Nelson 1953, Nigro, D., personal observation). They were also found nesting on dry tundra sites along low bluffs of the Utukok River.

Threats to this species include loss of wetlands at migratory stopover sites, changes in breeding habitat due to effects of climate change, and potential negative effects from oil and gas exploration and drilling (e.g., loss of habitat, disturbance) including potential increases in predation of eggs and young if industrial and community development provide opportunities for increases in predator populations on the nesting grounds.

Northern Pintail

The northern pintail (*Anas acuta*) has a circumpolar distribution with core nesting habitats occurring in Alaska and the prairie pothole region of southern Canada and the Northern Great Plains (Austin and Miller 1995). Northern pintails winter from southeastern Alaska and south throughout much of the central and southern U.S. and into Mexico and the Caribbean. Northern pintail is the most abundant duck found in the planning area. Pintail numbers fluctuate from year to year, but no significant population trends have been reported since aerial surveys began in the mid-1980s (Larned et al. 2011). Numbers may vary by as much as 62 percent between low and high population years, probably as a result of a northward displacement from southern nesting areas during drought years (Derksen and Eldridge 1980). In 2010, the northern pintail population index of 40,057 was 18 percent below the long-term average (Larned et al. 2011). Although no significant population trends are evident on the Arctic Coastal Plain, northern pintail populations in the lower 48 states and Canada have declined (U.S. Fish and Wildlife Service 2004). Pintails are distributed throughout the NPR-A within 60 kilometers of the coast in moderate densities and are concentrated in high densities north and east of Teshekpuk Lake, south and east of Barrow and near Cape Simpson (Larned et al. 2011) (see Map 3.3.5-17). In the southern portion of the Reserve, pintails have been observed in most areas where bird research has been conducted, although no waterfowl specific surveys have been conducted (Austin and Miller 1995, Gabrielson and Lincoln 1959, Irving and Paneak 1954, Kessel and Cade 1958, Reed 1956). In Alaska, pintails nest on wet sedge or grass meadows, slough and riverbanks, pond shores, and in tidal habitat (Austin and Miller 1995). Derksen et al. (1981) found the pintail to be a casual breeder at Singiluk with a preference for *Arctophila* wetlands for both nesting and brood rearing. Bergman et al. (1977) found that northern pintails make intensive use of flooded tundra during spring thaw and during the wing molt period.

Threats to this species include loss of wetlands at migratory stopover sites, changes in breeding habitat due to effects of climate change leading to greater numbers of birds overflying the prairie pothole region and nesting on the Arctic Coastal Plain, and potential negative effects from oil and gas exploration and drilling (e.g., loss of habitat, disturbance) including potential increases in predation of eggs and young if industrial and community development provide opportunities for increases in predator populations on the nesting grounds.

Long-tailed Duck

The long-tailed duck (*Clangula hyemalis*) breeds in tundra and taiga regions around the globe, as far north as 80 °N (Robertson and Savard 2002). After breeding, they migrate to cold and temperate-water coasts of North America, western Greenland, eastern Asia, and the Great Lakes. Males leave the nesting area during hatch, moving to large coastal plain lakes, Beaufort Sea lagoons and nearshore waters with nonbreeders and failed breeders to molt, often in large flocks (Derksen et al. 1981, Flint et al. 2003, Garner and Reynolds 1986). Shortly after hatch, females lead the young to lakes where the females molt prior to fall migration (Derksen et al. 1981). Following molt, they occupy coastal lagoons for staging, with substantial numbers of birds using Kasegaluk Lagoon (Johnson et al. 1993), until migration begins in late September. Long-tailed duck is the second most abundant duck on the Arctic Coastal Plain (Larned et al. 2011). The 2010 long-tailed duck population index was 24,557 birds and is just below the 19-year-mean of 30,396 birds, indicating a very slight negative growth trend (Larned et al. 2011). The highest densities of long-tailed ducks in the NPR-A occur to the southeast of Teshekpuk Lake, along Kealok, Fish, Inigok and Judy creeks, south of Admiralty Bay and along the Kikiakrorak and Kuk rivers; however, overall, the species is very uniformly dispersed throughout most of the survey area (see Map 3.3.5-18). Research in the Beaufort Sea lagoons to the east of the NPR-A determined that long-tailed ducks congregated in the lagoon system of the Beaufort Sea for a post-breeding molt period from mid-July through mid-September, and that during this time the lagoons may contain 10,000 to 30,000 flightless long-tail ducks with the birds foraging in the lagoons in the daytime and roosting on the barrier islands at night (Flint et al. 2003). In the southern portion of the NPR-A, long-tailed duck have been observed in most areas where avian research has been conducted, although no waterfowl-specific surveys have been conducted (USDOI 1978, Gabrielson and Lincoln 1959, Irving and Paneak 1954, Kessel and Cade 1958, Reed 1956, Robertson and Savard 2002. Derksen et al. (1981) found the long-tailed duck abundant at all of their study sites in NPR-A, with the highest densities recorded at their sites nearest to the foothills region.

Threats to this species include loss of wetlands at migratory stopover sites, changes in breeding habitat due to effects of climate change, and potential negative effects from oil and gas exploration and drilling (e.g., loss of habitat, disturbance) including potential increases in predation of eggs and young if industrial and community development provide opportunities for increases in predator populations on the nesting grounds. Due to their behavior to congregate in large groups during molt, long-tailed ducks would be particularly vulnerable to an oil spill in these areas.

King Eider

King eiders (*Somateria spectabilis*) breed along the Arctic coasts of Alaska. They winter mostly in the Bering Sea with some individuals occasionally remaining in the Chukchi Sea (Suydam 2002). According to data derived from migration counts at Point Barrow, the western Arctic population of king eiders appears to have declined by 55 percent between 1796 and 1996 (Suydan et al. 2000). Despite the declining trend at Point Barrow, the U.S. Fish and Wildlife Service's 2010 king eider population index (15,715) is 13 percent above the long-term mean, indication a slightly increasing population (Larned et al. 2011). Within the NPR-A, the largest concentration of king eiders is in the area immediately south and east of Teshekpuk Lake (Larned et al. 2011) (see Map 3.3.5-19).

Female king eiders exhibit strong site fidelity to breeding areas on the North Slope (Phillips and Powell 2006). Noel et al. (2001) reported two flocks of eider hens and ducklings on a lake southeast of Teshekpuk Lake that contained approximately 800 birds in late July. Only one nest was discovered during ground searches around the entire perimeter of this lake during the incubation period, indicating that areas important for brood rearing may not necessarily be important for nesting, and that broods may move some distance from nests. Phillips et al. (2007) found that female king eiders were most concentrated in the areas of Smith and Harrison bays during post-breeding, spending 2 weeks staging there prior to molt migration, whereas males had a much broader distribution in the Beaufort Sea (see Map 3.3.5-19). Dispersing king eiders move through the Beaufort Sea to molting and wintering locations in the Bering Sea (Phillips et al. 2007). Phillips et al. (2007) also documented previously undescribed molt and wintering locations in the Beaufort Sea and near the Kamchatka Peninsula on its west coast and in Olyutor Bay at the peninsula's southern-most tip. In the southern portion of the NPR-A, Derksen et al. (1981) classified king eiders as unusual breeders at Singulik, and contend that there is no evidence that the species occurs south of the coastal plain. At Storkensen Point, Bergman et al. (1977) found that both shallow and deep ponds and lakes were favored by king eiders in all phases of their reproductive cycle.

The most serious threat to king eiders from potential oil and gas development is the possibility of an oil spill in the molting and brood-rearing areas where large numbers of birds congregate. Other threats include changes in breeding habitat due to effects of climate change, and potential negative effects from oil and gas exploration and drilling due to loss of habitat, disturbance and potential increases in predation of eggs and young if industrial and community development provide opportunities for increases in predator populations on the nesting grounds.

Common Eider

Common eiders (*Somateria mollissima*) have a circumpolar distribution, and in general, inhabit Arctic and sub-Arctic coastal marine habitats (Goudie et al. 2000). In Alaska, common eiders breed along the Pacific and Arctic coasts and winter chiefly in the Bering Sea south to and including the Aleutian Islands with some birds wintering in the Bering Strait and Beaufort Sea where open water remains (Goudie et al. 2000). According to population trends derived from migration counts at Point Barrow, the common eider population declined by 53 percent between 1976 (156,081 birds) and 1996 (72,606 birds); reasons for this apparent decline are unknown (Suydam et al. 2000b). In the NPR-A, common eiders nest in loose aggregations or small colonies on barrier islands, and at a few coastal areas. A westward molt migration of males takes place in late June and early July; with a majority of these birds migrating within 50 kilometers of the coast (Bartels and Zellhoefer 1983). Females and young from across the Arctic migrate westward through the Beaufort Sea in late August and early September. Substantial numbers of birds stage in coastal lagoons, including Kasegaluk Lagoon in the Chukchi Sea, from late July to September (Johnson 1993). Aerial surveys flown annually by U.S. Fish and Wildlife Service do not detect many common eiders because these surveys do not include offshore barrier islands. Nearshore surveys along the Beaufort and Chukchi shorelines and barrier islands in 2009 recorded 173 common eiders from Icy Cape north to Point Barrow and east to Smith Bay (Dau and Bollinger 2009). Near shore coastal distributions during nesting surveys indicate that breeding pairs of common eiders are more numerous along the coast between the Colville River delta and the Canadian border than they are along the coast of the NPR-A (Dau and Bollinger 2009). The lack of barrier islands (a favorite nesting habitat) near the coastline of the NPR-A is thought to contribute to the low numbers of common eiders found there. Aerial surveys conducted during the early incubation period along the entire Arctic Coastal Plain between 1999 and 2002 showed that less than 1 percent of all common eiders detected were found along Beaufort Sea shoreline segments in the NPR-A.

The most serious threat to common eiders from potential oil and gas development is the possibility of an oil spill in the molting areas where large numbers of birds congregate. Other threats include changes in breeding habitat due to effects of climate change, and potential negative effects from oil and gas exploration and drilling due to loss of habitat, disturbance and potential increases in predation of eggs and young if industrial and community development provide opportunities for increases in predator populations on the nesting grounds.

3.3.5.6 Shorebirds

The Reserve is a highly productive area for breeding shorebirds. In particular, the northern region has been shown to have significantly higher nesting densities of several species of shorebirds than other regions of the North Slope or other areas in Alaska and it has also been shown that several species of shorebirds nesting in the Teshekpuk Lake Special Area show higher nest survivorship as compared to those species nesting near existing oilfield infrastructure to the east of the NPR-A. Certain coastal areas of the Reserve also host large concentrations of postbreeding shorebirds in the late summer, which is when they acquire fuel resources necessary for fall migration. In general, shorebirds are present on the North Slope from May to September. After hatching, brood-rearing shorebirds move to tundra and aquatic habitats adjacent to their nests. Many shorebirds move to coastal habitats to feed before migrating. Adults often migrate before juvenile birds, and juvenile shorebirds may not leave until late August or September (Johnson and Herter 1989, Andres 1994). Fall flocks may sometimes be composed entirely of juvenile birds. Wintering areas for shorebirds vary among species and include locations in the contiguous U.S., Mexico, Central and South America, Asia, and Africa. One shorebird species occurring in the NPR-A, the red knot (*Calidris canutus*), is on the BLM Sensitive Species List for Alaska (Appendix J) and is discussed in section 3.3.8.2.

At least 29 species of shorebirds breed in the planning area (Johnson et al. 2007) and as many as 6 million shorebirds are thought to spend the summer in the NPR-A (Pitelka 1974, Cotter and Andres 2000) with the most abundant species being American golden-plover (*Pluvialis dominica*), semipalmated sandpiper (*Calidris pusilla*), pectoral sandpiper (*Calidris melanotos*), dunlin (*Calidris alpine*), long-billed dowitcher (*Limnodromus scolopaceus*), red-necked phalarope (*Phalaropus lobatus*), and red phalarope (*Phalaropus fulicarius*). A number of shorebird species that breed or regularly occur in the NPR-A are considered to be species that are highly imperiled or are species of high concern in the Canadian and U.S. Shorebird Conservation Plans (Donaldson et al. 2001, Brown et al. 2001, respectively). The 2008 Alaska Shorebird Conservation Plan lists the American golden-plover, upland sandpiper (*Bartramia longicauda*), whimbrel (*Numenius phaeopus*), bar-tailed godwit (*Limosa lapponica*), red knot, buff-breasted sandpiper (*Tryngites subruficollis*), sanderling (*Calidris alba*), and the arcticola subspecies of the dunlin as priority species (Alaska Shorebird Group 2008). All of the above-listed species either breed or regularly occur in the planning area. Several sites within the NPR-A have been recognized by the National Audubon Society and Birdlife International program as Important Bird Areas for shorebirds (see Map 3.3.5-4), including Kasegaluk Lagoon, Teshekpuk Lake, east Dease Inlet, Peard Bay, Elson Lagoon, and the Colville River delta.[15]

Within the Reserve, high numbers and diversity of breeding shorebirds are found in areas including Barrow and the areas surrounding Admiralty Bay, the Kogru River, the Ikpikpuk River and delta, and the area surrounding Teshekpuk Lake (Troy Ecological Research Associates 1993, Mallek et al. 2006, Alaska Shorebird Group 2008). Johnson et al. (2007) conducted research that indicates nesting individuals of seven shorebird species were present on significantly more plots in the western part of the Arctic Coastal Plain (Icy Cape to Colville River, much of which is within the NPR-A) than in the eastern portion (Colville River to Aichilik River). These species included the bar-tailed godwit, semipalmated sandpiper, pectoral sandpiper (*Calidris melanotos*), dunlin, long-billed dowitcher, red phalarope, and western sandpiper (*Calidris mauri*). Only one species, the American golden-plover, was more prevalent in the eastern than the western portion of the Arctic Coastal Plain. Similarly, survey plots supported a significantly higher average number of species in the west (5.0 ± 0.37) than in the east (3.9 ± 0.41). Within NPR-A, the highest species richness occurred at Admiralty Bay, the Alaktak River, the Ikpikpuk River and delta, the area surrounding Teshekpuk Lake, and the Fish Creek delta (Johnson et al. 2007).

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[15] http://www.audubon.org/bird/iba/

Andres (2004) reported that latitude was the best predictor of shorebird density and species richness for all species combined in the NPR-A, with higher densities recorded in more northern latitudes. The greatest densities occurred at sites with high percentages of flooded and wet sedge-moss vegetation types; densities were lower at inland sites, which were drier and had more shrubs. In the northern portion of the NPR-A, the most abundant species detected by Andres (2004) were semipalmated and pectoral sandpipers, and red phalarope. Shorebird nesting densities on the Arctic Coastal Plain vary depending on location and habitat. Cotter and Andres (2000) reported shorebird nest densities of 77.7 nests per square kilometer on study plots in drained-lake basin habitat, but only 12.9 nests per square kilometer on tussock/ridge tundra in the central portion of the planning area. Johnson et al. (2003b) considered all habitats and reported a greater overall shorebird nest density of almost 90.6 nests per square kilometer on the Colville River delta near the Alpine field, where nests were associated with two habitat types: wet sedge willow and moist sedge shrub. One of the most important areas for shorebirds in the NPR-A may be the area north of Teshekpuk Lake where Andres (2004) reported shorebird densities as high as 137.3 pairs per square kilometer in areas northeast and northwest of the lake. Burgess et al. (2003) reported 12 shorebird species nesting on intensively searched study plots in the eastern portion of the planning area during 2 years of study. A study conducted in the Olak region of the Teshekpuk Lake Special Area (see Map 3.3.5-4) during 2006–2008 found 12 species of shorebirds in the study area with pectoral and semipalmated sandpipers and red phalaropes accounting for the greatest numbers of nests found (Liebezeit and Zack 2006, 2007, 2008). Liebezeit and Zack (2006) found overall nest density (all nests of all species including non-shorebird species) to be 132.4 nests/square kilometer in 2006, 100.1 nests/square kilometer in 2007 and 98.9 nests/square kilometer in 2008. They also found that nest predation was the most important cause of nest failure.

A bird monitoring study conducted between 1998 and 2001 surveyed 386 variable-sized plots distributed throughout the NPR-A, which together covered 112 square kilometers (Bart and Earnst 2005). The surveyed area represents about 0.47 percent of the approximately 24,000 square kilometer planning area. Biologists counted 4,445 shorebirds belonging to 17 species during the four survey years. The highest counts of shorebirds occurred in the northern portion of the planning area, followed by areas near the Colville River, and then the southern portion of NPR-A. The most numerous species detected were semipalmated sandpiper (1153), pectoral sandpiper (943), red phalarope (669), red-necked phalarope (435), long-billed dowitcher (353), and dunlin (343) (Bart and Earnst 2005). Other less common species included black-bellied plover, American golden-plover, whimbrel, bar-tailed Godwit, ruddy turnstone (*Arenaria interpres*), western sandpiper, white-rumped sandpiper (*Calidris fuscicollis*), Baird's sandpiper (*Calidris bairdii*), buff-breasted sandpiper, stilt sandpiper (*Calidris himantopus*), and Wilson's snipe (*Gallinago delicate*) (Bart and Earnst 2005). Four of the species (dunlin, whimbrel, bar-tailed Godwit, and buff-breasted sandpiper) are on the U.S. Fish and Wildlife Service's Birds of Conservation Concern list for the Arctic Plains and Mountains Bird Conservation Region.

A preliminary analysis (Bart and Earnst 2005) that extrapolated the densities of the most abundant shorebirds (based on a double sampling approach used to determine detection rates) using the Ducks Unlimited land cover information in a regression model, estimated that between 356,000 and 455,000 (95 percent confidence intervals) shorebirds were present in the eastern portion of the NPR-A. Application of the estimation procedure in each of 22 sub-regions showed that numbers were slightly higher closer to the coast (Bart and Earnst 2005). Cotter and Andres (2000) recorded 13 species of shorebirds nesting near Inigok (see Map 3.3.5-4), the furthest inland study of shorebirds that has been conducted in the NPR-A. Although comprising only 10.5 percent of the total tundra at Inigok, nest density was highest in drained lake basins, indicating a strong preference for this type of habitat. Semipalmated and pectoral sandpipers, the most abundant shorebirds breeding at Inigok, were found nesting exclusively in this landform (Cotter and Andres 2000). Only the American golden-plover was found nesting in appreciable numbers in tussock/ridge tundra in the study area (Cotter and Andres 2000).

Shorebirds worldwide have suffered dramatic population declines in the last decade (Meltofte et al. 2007). Around the world, loss of wetland habitat represents the greatest threat to shorebird populations. Non-breeding and migratory stopover areas outside of Alaska that are important to the State's shorebirds are being altered primarily through drainage and reclamation of coastal wetlands. Disturbance or habitat loss along the planning area coastline could result in population-level consequences to shorebirds if an oil spill were to occur during peak staging, or if food availability is diminished to the point where low fat accumulation and deposition rates preclude successful migration. Shorebird habitats are threatened worldwide by changes predicted to occur through global climate change. The effect of climate change on shorebirds breeding in the NPR-A is uncertain. Initially, climate change may benefit Arctic shorebirds because of earlier snowmelt and warmer summers with more stable food availability for adults and chicks, but in the longer term overgrowing of the tundra with shrubs and trees will probably reduce their breeding habitats significantly (Meltofte et al. 2007). Additionally, increasing spring phenology is advancing the period of peak insect abundance in tundra habitats. If shorebirds are unable to advance their breeding phenology to maintain the synchrony between peak insect emergence and chick hatch, this mismatch in timing could significantly impact shorebird reproductive success across the Arctic (Tulp and Schekkerman 2008).

A recent study investigating post-breeding concentrations and staging areas of shorebirds in the planning area indicate high levels of connectivity among coastal staging areas, and all staging sites that were studied were used by more than one species throughout the post-breeding period. Individuals captured on nests were found to use staging sites both on the coast near their breeding site and at additional staging sites distant from their breeding sites (Taylor et al. 2010a). These results suggest that shorebirds breeding in the NPR-A rely on multiple, dispersed sites for fall staging, and that a concentration of shorebirds at a given location may represent individuals from a much wider range than the local tundra breeding area. It appears that the northern Alaska coastline is a network of interconnected staging sites, each hosting multiple breeding populations of shorebirds (Taylor et al. 2010a). As such, birds staging along this coastline may be more vulnerable to potential spills of oil or other toxic chemicals if those spills occur during the post-breeding period when large numbers of shorebirds from multiple populations occur in the same area.

Post-breeding Shorebirds

Seasonal habitat use within the shorebird group is variable, but there is a marked general post-breeding movement by many species from tundra habitats occupied for nesting to marine littoral zone, saltmarsh, and barrier-island habitats for migration staging in late summer and into early September (Andres 1994, Connors et al. 1981, Rothe et al. 1983, Smith and Connors 1993). For some species, this may result in rapid post-breeding population increases in these habitats. Shorebirds breeding in the NPR-A migrate to many parts of the world, including Japan and Asia (dunlin), New Zealand (bar-tailed godwit), southern South America (e.g., pectoral sandpiper, American golden-plover, buff-breasted sandpiper), Central America (e.g., western sandpiper, semipalmated sandpiper), and east coast of North America (red-necked phalarope). Long-distance migrations, such as those taken by the majority of the species nesting in the planning area, are energetically expensive. The ability of these birds to acquire sufficient fat reserves is crucial to accomplishing such migrations (Alerstam and Lindström 1990, Lindström 1991). For shorebirds breeding in the Reserve, much of this pre-migratory fattening is likely accomplished in coastal areas along the Beaufort and Chukchi seas.

Four fixed-wing aerial surveys for post-breeding shorebirds were conducted along the coast of the Arctic Coastal Plain during late July through August of 2006. These surveys were designed to count all shorebirds along the coast of the Arctic Coastal Plain from Kaseguluk Lagoon to the Canadian Border. When survey data were restricted to only those coastal areas within NPR-A and a visibility correction factor applied, the resulting estimates of small shorebirds ranged between 50,000 and 100,000 birds (Taylor 2011). Within the surveyed portion of the planning area, numbers of small shorebirds increased throughout the survey period.

The river deltas and coastal lagoons of the NPR-A are used extensively by post-breeding shorebirds from July through September to build energy reserves necessary for migration to wintering areas. Some of the more important areas for shorebirds are described below. Kasegaluk Lagoon is one of the longest lagoon barrier island systems in the world, and is used by over 19 different species of shorebirds during fall migration. Up to 68,000 post-breeding shorebirds are estimated to use the Kasegaluk Lagoon system between July and September (Taylor, A., unpublished data). These are mostly juvenile semipalmated and western sandpipers, dunlin, and red phalaropes. Peard Bay is a large, relatively deep bay, located on the north Chukchi Sea Coast west of Barrow. It is protected on the north by a 25-kilometer-long sand spit and a series of small barrier islands. Upwards of 56,000 shorebirds are thought to use Peard Bay during the post-breeding season (Taylor, A., unpublished data), with red phalaropes comprising the majority. Other species present in substantial numbers included semipalmated sandpipers, western sandpipers, pectoral sandpipers, and dunlin.

Elson Lagoon is another large, mostly closed lagoon protected from the Beaufort Sea by barrier islands and spits. The lagoon extends from Point Barrow to Cape Simpson, and includes the Plover Islands and the mouth of Dease Inlet to Black Head. The area is also heavily used by post-breeding shorebirds, with as many as 418,000 shorebirds stopping there throughout fall migration (more than 90 percent phalaropes; Taylor, A., unpublished data). Farther to the east, Pogik Bay, a small inlet located north of Teshekpuk Lake, has contained at least 21,000 shorebirds during the peak of post-breeding staging (Taylor 2011.) The Colville River delta hosts an estimated 40,000 individuals of 18 species during fall migration, including large numbers of American golden-plovers, dunlin, and stilt sandpipers (Andres 1994). More contemporary surveys report single-day counts of up to 17,000 dunlin on the Colville Delta (Taylor, A., unpublished data). Counts of individual shorebirds of different species occurring over less than the entire staging period should consider the varying lengths of stay of each species: a radio telemetry study of five common species staging on the northern coast of Alaska found that semipalmated sandpipers and phalaropes may remain at staging areas more briefly (3 to 5 days post capture) than western sandpipers (4 to 12 days post capture) or dunlin (8 to 18 days post capture) (Taylor et al. 2010b).

Plovers

Two plover species are regularly observed in the NPR-A; the American golden-plover and the black-bellied plover.

Black-bellied Plover

The black-bellied plover is known to nest on open, relatively dry heath tundra in the lowlands, both near the coast and varying distances from the coast, but not high in the mountains (Paulson 1995). Irving (1960) reports few sightings of black-bellied plovers in the Anaktuvuk Pass area. They winter on the west coasts of North and South America, from southern British Columbia south to Chile, and on the east coasts of North and South America from New Jersey to Argentina (Terres 1982). There are no recent records of distribution or abundance available for this species in the NPR-A. Derksen et al. (1981) considered the black-bellied plover to be an uncommon breeder, restricted almost entirely to drier sites at Singiluk. Cotter and Andres (2000) found only 23 pairs and 2 nests of black-bellied plover at their Inigok study site, and these nests were located on sparsely vegetated hummocks in drained lake basins. Liebezeit and Zack (2006, 2007, 2008) considered black-bellied plovers to be a common species during the three years of their study southeast of Teshekpuk Lake. Black-bellied plover is listed as a species of low to moderate concern by the Alaska Shorebird Conservation Plan (2008).

American Golden-plover

American golden-plovers also nest in dry upland sites where their nests consist of scrapes on the tundra that are lined with mosses and lichens and are found during winter on the plains of central South America (Johnson and Conners 2010). American golden-plover nest densities generally range from approximately 0.3 to 4.1 nests per square kilometer (Troy Ecological Research Associates 1992, Cotter and Andres 2000, Johnson et al. 2003, Burgess et al. 2003b). Cotter and Andres (2000) found American golden-plover nests (1.56 nests/kilometer) in ridge tundra or on sparsely vegetated hummocks in tussock tundra at Inigok. Derksen et al. (1981) considered the American golden-plover to be an uncommon breeder restricted almost entirely to drier sites at Singiluk. Kessel and Cade (1958) found American golden-plovers using mesic tundra sites scattered between the mouth of the Kiligwa River and along the Colville River. Maher (1959) classified American golden-plovers as being a common nesting species using dwarf shrub-sedge tundra for nesting at his study area on the upper Kaolak River. Liebezeit and Zack (2006, 2007, 2008) considered American golden-plovers to be a common species with nest densities of 3.1, 0.6, and 2.5 nests/square kilometer, respectively, during the 3 years of their study southeast of Teshekpuk Lake.

American golden-plover is listed as a species of high concern and is listed as a priority species in Alaska by the Alaska Shorebird Conservation Plan (2008). Despite a population estimate of 200,000 (Morrison et al. 2006), there is concern because of an apparent population decline and significant potential threats on the nonbreeding grounds (Brown et al. 2001). Changing agricultural practices at spring staging areas in Indiana and Illinois, exposure to agricultural pesticides during much of the spring migration in North America, and the loss of suitable habitat on the nonbreeding grounds in South America are probably the most important potential threats to the species (Alaska Shorebird Conservation Plan 2008, Johnson 2003).

Sandpipers and Phalaropes

Sandpipers and phalaropes considered common to abundant in the northern portion of the planning area include dunlin, semipalmated sandpiper, pectoral sandpiper, stilt sandpiper, long-billed dowitcher, red-necked phalarope, and red phalarope. These shorebird species use a wide variety of habitat types, but tend to nest in wet and moist sedge meadows and aquatic sedge and grass marshes. Dunlin, semipalmated and pectoral sandpipers may also nest in drier habitats including moist tussock tundra (Johnson and Herter 1989). In the southern portion of the NPR-A, there is a lack of quantitative data regarding the abundance and distribution of sandpipers and phalaropes, but most historic and contemporary references consider them to be at least present (Johnson et al. 2007, USDOI 1978).

Semipalmated Sandpiper

Semipalmated sandpipers are found nesting in low and sub-Arctic tundra, near water along the Alaskan coast (above 56 °N) across Canada to northern Quebec, central Baffin Island and northern Labrador (Hicklin and Gratto-Trevor 2010). Semipalmated sandpipers have been found nesting in river deltas in dry shrubby areas and mixed sedges and grasses; variably drained upland tundra with low vegetation near small ponds, lakes, and streams; moist or wet sedge-grass or heath tundra; sandy areas along rivers; and pond-dotted sand dunes (Gratto-Trevor 1992). Semipalmated sandpipers winter from Florida south along coastal areas through Central America to southern Brazil and from Guatemala to northern Chile (Terres 1982). At Singiluk, Derksen et al. (1981) found semipalmated sandpiper to be a common breeder (6.9 birds/square kilometer). Cotter and Andres (2000) reported that semipalmated sandpipers at their study site near Inigok nested exclusively in drained lake basins. Kessel and Cade (1958) found semipalmated sandpiper in mesic tundra along the Colville River. During a 3-year study in the eastern portion of the NPR-A, semipalmated sandpiper nest density averaged 10.9 nests per kilometer on study plots near Fish Creek (Burgess et al. 2003), and 10.4 nests/square kilometer in the Olak region (Liebezeit and Zack 2006, 2007, 2008). During a ground-based study of post-breeding conducted across the Arctic Coastal Plain, semipalmated sandpipers were found in greater numbers at the Colville and Sagavanirktok delta than elsewhere (Taylor et al. 2010a). Shorebird movement patterns were investigated across the Arctic Coastal Plain via telemetry surveys, and the majority of semipalmated sandpiper that were re-sighted during the study had moved eastward across the northern coast of Alaska in a rapid and unidirectional manner that did not make use of multiple staging sites (Taylor et al. 2010b).

On-the-ground research of habitat use at fall staging areas within the coastal areas of

NPR-A showed that semipalmated sandpipers strongly selected for mudflat habitat (Taylor et al. 2010a).

Semipalmated sandpiper is listed as a species of low to moderate concern by the Alaska Shorebird Conservation Plan (2008). Prior to the signing of the Migratory Birds Convention in 1916, numbers of semipalmated sandpipers were decreasing rapidly in Canada and the U.S. (Hicklin and Gratto-Trevor 2010). The hunting of sandpipers, both legal and illegal, still exists in northern South America (Hicklin and Gratto-Trevor 2010), and conservation of populations is further challenged by destruction or manipulation of coastal and inland wetlands as well as by environmental contaminants (Senner and Howe 1984, Hung and Chmura 2006, Braune and Nobel 2009).

Pectoral Sandpiper

In the NPR-A, the pectoral sandpiper is found breeding in wet tundra along the Arctic Coastal Plain from near the coast inland to the foothills (Holmes and Pitelka 1998). Pectoral sandpipers usually breed on relatively flat and marshy tundra that is vegetated by sedges and grasses, but that also contains raised ridges or hummocks that provide suitable nest sites (Holmes and Pitelka 1998). In the northern portion of the planning area, pectoral sandpipers are most common on the Arctic Coastal Plain in sites with low-lying ponds and marshy ground or with a mosaic of raised hummocks interspersed with marshy areas (Conners et al. 1979, Pitelka 1959). The species is almost entirely absent from dry coastal tundra (Troy 1994). They also have been found, at lower densities, inland from the Arctic Coast in areas with cotton grass tussock-dwarf shrub tundra (Conners et al. 1979, Pitelka 1959).

At Singiluk, Derksen et al. (1981) found pectoral sandpipers to be common breeders (24.1 birds/square kilometer) using ephemeral wetlands for feeding. Maher (1959) considered semipalmated sandpipers and pectoral sandpipers to be uncommon nesting birds in dwarf shrub-sedge tundra and in *Carex* marsh on his study area on the upper Kaolak River. Cotter and Andres (2002) reported that pectoral sandpipers in the NPR-A near Inigok nested exclusively in drained lake basins where nest density was 28.5 nests per square kilometer, although nest density in the entire study area was only 4.1 nests per square kilometer when all habitats were considered. In the northeastern portion of the NPR-A Liebezeit and Zack (2006, 2007, 2008) reported pectoral sandpiper nest densities of 20.0, 9.4, and 5.6 nests/square kilometer, respectively, for the 3 years of their study. On-the-ground research of habitat use at fall staging areas on the Arctic Coastal Plain showed that pectoral sandpipers selected for salt marshes and pond edge, which was often interspersed with salt marsh at littoral areas (Taylor et al. 2010a).

Pectoral sandpiper is listed as a species of low to moderate concern by the Alaska Shorebird Conservation Plan (2008). Troy (1991, 1993) found no effect of tundra disturbance on breeding abundances or nest densities or of tundra fragmentation on breeding abundance, nest density, or nest success at Prudhoe Bay 20 years after oil exploration began in the late 1960s although abundance of breeding adults was found to be lower near recently constructed roads within oil fields (Troy 1993).

Dunlin

Dunlin breed on sub-Arctic and Arctic coastal tundra from southwestern Alaska north and east to James Bay, Canada (Warnock and Gill 1996). The subspecies that occurs in northern Alaska (*Calidris alpina arcticola*) is found most commonly between Point Barrow and Prudhoe Bay (Warnock and Gill 1996).

Dunlin use a wide range of habitat types, but are more abundant near the coast than inland (Derksen et al. 1981, Johnson and Herter 1989). Most dunlin that breed in the NPR-A probably winter along the coast lines of China and Japan. Research conducted in the Prudhoe Bay area found that breeding dunlin use moist-wet tundra, often in areas with ponds, polygons, and strangs (short, sinuous ridges that form perpendicular to the direction of the local hydrologic gradient). They are commonly found in recently formed landscapes such as drained thaw lakes (Warnock and Gill 1996). Dunlin have been found nesting in the southern portion of the NPR-A at Inigok with nest densities of 1.32 nests/square kilometer in tussock/ridge tundra (Cotter and Andres 2000). In the northeast portion of the Reserve, average nest density was 1.6 nests/square kilometer (Burgess et al. 2003) near Fish Creek, and ranged from 1.9 to 5.6 nests per square kilometer during a 3-year study southeast of Teshekpuk Lake (Liebezeit and Zack 2006, 2007, 2008).

During a ground-based study of post breeding conducted across the Arctic Coastal Plain, dunlin were found in greater numbers at the Kasegaluk Lagoon, Colville Delta, and the Sagavanirktok Delta camps than elsewhere (Taylor et al. 2010a). During post-breeding shorebird surveys on the Colville River Delta, dunlins comprised about 50 percent of all sightings and were the most abundant species on coastal shoreline silt barrens (Andres 1994). Shorebird movement patterns were investigated across the Arctic Coastal Plain via telemetry surveys in which dunlin were found to move both east and west across the study area (Taylor et al. 2010b). Andres (1989) also observed bi-directional movements of dunlin during his work at the Colville River Delta: 67 percent of dunlin groups were observed moving west while 22 percent were observed moving east. The east/west movements of dunlin in these two studies may be a function of the long staging period this species exhibits on the northern Alaska Coast. It seems likely that individuals may have moved back and forth between staging areas, depending on weather and intertidal conditions that influenced food availability and thus their ability to replace flight feathers while acquiring fat resources for southbound migration. Ground-based research of habitat use at fall staging areas in the planning area showed that dunlin selected for salt marsh habitat (Taylor et al. 2010a).

Despite the relatively large population size of dunlin (between 200,000 and 750,000 birds) (Morrison et al. 2006, Alaska Shorebird Group 2008), this subspecies is of high conservation concern and is listed as a priority species in Alaska by the Alaska Shorebird Conservation Plan (2008). This is due to a significant population decline documented on the North Slope of Alaska and because of the high rate of nonbreeding habitat loss in East Asia (Barter 2003, Alaska Shorebird Group 2008).

Long-billed Dowitcher

Long-billed dowitcher is known to occur throughout northern Alaska south to the foothills of the Brooks Range (Takekawa and Warnock 2000). Johnson and Herter (1989) reported that long-billed dowitcher is more abundant farther inland from the coast. They use a variety of nesting habitats across the Arctic Coastal Plain, but appear to prefer wet habitats associated with strangmoor (Troy 2000). Long-billed dowitchers winter from the southern U.S. south through Mexico to Panama (Terres 1982). Cotter and Andres (2000) found long-billed dowitchers nesting at densities of 2.97 nests/square kilometer on their study area near Inigok with higher densities in drained-lake basins when compared to tussock/ridge tundra. Long-billed dowitcher nest density ranges from 0 to 7.5 nests/square kilometer, averaging 5.7 nests/square kilometer in the northeastern portion of the NPR-A (Burgess et al. 2003), 2.6 nests per square kilometer in the central portion of the planning area (Cotter and Andres 2000) and 5.6 to 8.1 nests/square kilometer in the area around Olak, near Teshekpuk Lake's southeastern shore (Liebezeit and Zack 2006, 2007, 2008).

Long-billed dowitcher is listed as a species of low to moderate concern by the Alaska Shorebird Group (2008). Loss of wetlands in the contiguous U.S. is likely to have a negative impact on migrating and wintering populations (Takekawa and Warnock 2000).

Red Phalarope

Red phalarope have a circumpolar Arctic and sub-Arctic distribution and are primarily found on coastal tundra (Johnson and Herter 1989). Myers (1981) reports some nesting up to 50 kilometers inland from the coast in northern Alaska. Unlike red-necked phalarope, red phalaropes do not breed in alpine tundra (Tracy et al. 2002). Red phalaropes have been found breeding primarily in poorly drained hummocky terrain with abundant shallow ponds dominated by sedges (Tracy et al. 2002). Phalaropes winter at sea in the Pacific and Indian oceans, and off of the west and south coasts of Africa (Terres 1982). Kessel and Cade (1958) and Irving (1960) considered the red phalarope to be a spring migrant through the southern portion of the NPR-A. Cotter and Andres (2000) did not find red phalaropes nesting at their study site at Inigok. Derksen et al. (1981) found red phalaropes to be uncommon breeders (4.0 birds/square kilometer) at their inland study site of Singiluk while they were common breeders at their coastal study sites. Red phalarope nest density was found to be 2.1 nests per square kilometer at one study site in the eastern portion of the planning area (Burgess et al. 2003). Liebezeit and Zack (2006, 2007, 2008) found red phalaropes to be abundant and nesting in their study area southeast of Teshekpuk Lake at densities of 15.0, 7.5 and 5.0 nests/square kilometer, respectively, over the 3 years of their study. During a ground-based study of post breeding conducted across the Arctic Coastal Plain, red phalaropes were not found regularly east of the Colville Delta, but were recorded in large numbers at the Peard Bay and Point Barrow/Elson Lagoon camps where juvenile birds typically greatly outnumbered adults (Taylor et al. 2010a).

Shorebird movement patterns were investigated across the Arctic Coastal Plain via telemetry surveys, and red phalaropes were found to move both eastward and westward across the coast of the NPR-A, contrary to what was expected (Taylor et al., in press). Taylor et al. (in press) present several potential explanations for why phalaropes may not always move west, the predicted direction of travel based on known migration routes. Some Siberian red phalaropes are thought to join North American populations staging in the Beaufort Sea prior to fall migration (Alerstam and Gudmundsson 1999). Red phalaropes captured by Taylor et al. (in press) that subsequently moved eastward could have been Siberian birds migrating through the study area from the west. On the ground research of habitat use at fall staging areas within the planning area showed that red phalarope showed approximately equal selection for gravel beach and pond edge habitats (Taylor et al. 2010).

Red phalarope is listed as a species of low to moderate concern by the Alaska Shorebird Group (2008). Collisions with powerlines have been shown to be a potential source of mortality to juvenile birds in coastal areas of the Arctic Coastal Plain (Tracy et al. 2002).

Red-necked Phalarope

Red-necked phalarope is a sub-Arctic circumpolar breeder. In Alaska, it breeds west of the Bering and Chukchi Sea coasts along the Arctic Ocean and Beaufort Sea coasts (Rubega et al. 2000). Red-necked phalarope uses tundra transition vegetation near freshwater lakes, and bogs and marshes near small streams for nesting (Rubega et al. 2000). In northern Alaska, nesting areas are characterized by high occurrence of water, low relief, and high percentage graminoid/low percentage shrub cover (Rubega et al. 2000). Red-necked phalaropes breed farther inland and at higher elevations than do red phalaropes (Rubega et al. 2000). Phalaropes winter at sea in the Pacific and Indian oceans, and off the west and south coasts of Africa (Terres 1982). Cotter and Andres (2000) found red-necked phalaropes nesting density to be higher in drained-lake basins than in upland tundra with a density of 10.0 nests/square kilometer in drain-lake basins in their study area near Inigok. Derksen et al. (1981) found red-necked phalaropes to be a common breeder (9.7 birds/square kilometer) in flooded tundra and shallow wetlands at Singiluk. Maher (1959) considered them regular breeders in wet tundra at his study site on the upper Kaolak River. Kessel and Cade (1958) and Irving (1960) considered the red-necked phalarope to be a spring migrant through the southern portion of the NPR-A. Red-necked phalarope nest density in the eastern portion of the Reserve was 6.5 nests per square kilometer (Burgess et al. 2003). Liebezeit and Zack (2006, 2007, 2008) found red-necked phalaropes to be abundant nesters at their study area southeast of Teshekpuk Lake at with densities of 6.3, 5.0 and 6.9 nests/square kilometer, respectively, over the 3 years of their study. During a ground-based study of post-breeding conducted across the Arctic Coastal Plain, the highest numbers of red-necked phalaropes occurred at the Point Barrow/Elson Lagoon and Okpilak camps. Red-necked phalaropes were abundant for only a short period of time at the Kasegaluk Lagoon, Peard Bay, and Okpilak (located in the Arctic National Wildlife Refuge) camps, while they remained abundant at the Point Barrow/Elson Lagoon, Colville Delta, and Sagavanirktok Delta camps for a longer period of time (Taylor et al. 2010b). On-the-ground research of habitat use at fall staging areas within the planning area showed that red-necked phalarope selected for pond edge habitats (Taylor et al. 2010a).

Red-necked phalarope is listed as a species of low to moderate concern by the Alaska Shorebird Group (2008). After breeding, red-necked phalaropes migrate to pelagic wintering areas. In eastern North America, massive flocks totaling millions of birds formerly staged in fall in the western Bay of Fundy; in recent years, these have disappeared and no cause has yet been identified (Rubega et al. 2000).

Buff-breasted Sandpiper

Buff-breasted sandpiper is a high Arctic breeder that breeds in Alaska from Point Barrow and Atqasuk eastward (Lanctot and Laredo 1994). Buff-breasted sandpiper is the only North American shorebird species that uses a lek mating system (Gotthardt and Lanctot 2002). Habitat use depends on sex and breeding stage; males display in the first snow-free areas, typically along barren ridges, creek banks, and raised, well-drained areas with reticulate-patterned ground and scant vegetation (Lanctot and Laredo 1994). After snow melt, most males display together in moist, graminoid meadows. Nests are located on dry slopes with numerous sedge tussocks (Prevett and Barr 1976), on moss-willow-varied grass tundra and in moist or wet sedge-graminoid meadows on non-patterned or strangmoor ground (Lanctot and Laredo 1994). Buff-breasted sandpipers are highly site faithful to breeding territories and a loss or alteration of these traditional territories may prevent birds from breeding successfully, potentially leading to reduced productivity and lower recruitment rates. Derksen et al. (1981) did not find buff-breasted sandpipers at their study area at Singiluk. Kessel and Gibson (1978) report the buff-breasted sandpiper to be a rare spring migrant in the eastern Brooks Range and the foothills. In recent years, Cotter and Andres (2000) reported buff-breasted sandpipers nesting at Inigok in the central portion of the NPR-A, and Burgess et al. (2003) reported six nests on study plots in the eastern portion of the planning area. Liebezeit and Zack (2006, 2007, 2008) report buff-breasted sandpipers as uncommon with no nests located during 3 years of research at their study area southeast of Teshekpuk Lake.

Buff-breasted sandpipers winter primarily on the pampas of Argentina, Uruguay, and Brazil (Gotthardt and Lanctot 2002). Buff-breasted sandpiper is of high conservation concern because of its apparent decline from historical numbers, small population size (30,000), restricted nonbreeding distribution, and threats on the nonbreeding grounds (Brown et al. 2001, Morrison et al. 2006). Primary threats include habitat loss and exposure to pesticides along the migration route, human developments, and agricultural development of habitat used during the nonbreeding period in South America (Alaska Shorebird Group 2008). Due to buff-breasted sandpipers preference for dry habitats, they may have a higher vulnerability to oil and gas development in the NPR-A as the dryer areas are more suitable for placement of infrastructure.

Buff-breasted sandpiper is listed as an imperiled species in the U.S. Shorebird Conservation Plan (2004), of high conservation concern by Partners in Flight and in the Canadian shorebird conservation plans (Donaldson et al. 2001), and is listed as a Bird of Conservation Concern by the U.S. Fish and Wildlife Service. Historically, buff-breasted sandpiper numbers may have been in the millions, but their populations declined due to hunting and loss of habitat along its migratory route in the central United States and on its wintering grounds in South America (Terres 1982). The current worldwide population may number around 15,000 (Donaldson et al. 2001).

Bar-tailed Godwit

Bar-tailed godwit (*Limosa lapponica baueri*) occurs on Alaskan tundra from the sub-Arctic (southern limit, 58°45´N) to the Arctic (north to about 70°45´N) ranging from sea level to 440 meters above sea level in mountainous regions (McCaffery and Gill 2001). Bar-tailed godwit is known to breed on the north slope of the Brooks Range, in the foothills of the DeLong Mountains and east to at least the Utukok River (McCaffery and Gill 2001). Bar-tailed godwit is an uncommon breeding species on the Arctic Coastal Plain east to the Sagavanirktok River (Johnson and Herter 1989). Nests are found in areas dominated by moist tussock tundra, usually near wetlands, often in association with dwarf, low, and/or medium shrub thickets (McCafferty and Gill 2001). At their study site near Inigok, Cotter and Anders (2000) found bar-tailed godwit nests at densities of 2.5 nests/ square kilometer in drained lake basins. Field (1993) found that bar-tailed godwits select for aquatic sedge, sedge meadows, areas of open water and dwarf shrub. Maher (1959) considered the bar-tailed godwit to be scarce, but present in dwarf shrub-sedge tundra at his study site on the upper Koalak River. Bailey (1948) found then to be regular breeders 80 to 100 miles inland of Barrow. In recent years, bar-tailed godwit nests have been recorded in the Colville River delta and the eastern portion of the NPR-A (Burgess et al. 2003, Johnson et al. 2003). Liebezeit and Zack (2006) report bar-tailed godwits as a rare species in their study area and did not find any nests of the species. Bar-tailed godwits breeding in the planning area stage in the fall prior to their southward migration, in large concentrations along the coast of the Yukon-Kuskokwim Delta, and further south on the Alaska Peninsula before departing on the longest (11,000 kilometers) non-stop migration known for any shorebird species, across the Pacific Ocean down to New Zealand and southeast Australia where they spend the winter (Gill et al. 2005).

Bar-tailed godwit is listed as a species of high concern; it is listed as a priority species in Alaska by the Alaska Shorebird Group (2008), and a Bird of Conservation Concern by the U.S. Fish and Wildlife Service. Western and northern Alaska likely support the entire breeding population of the subspecies *baueri*. Despite a moderate population size (80,000–120,000 birds), this population is potentially at risk. The species is vulnerable to subsistence harvest throughout its annual cycle in Alaska, China and New Zealand (Alaska Shorebird Group 2008). The levels of harvest and their cumulative impacts on the population are largely unknown, but they could be significant. In addition, post-breeding surveys on the Yukon-Kuskokwim Delta suggest that large-scale reproductive failures occurred each year from 1999–2004, during which juveniles made up no more than 3 percent of staging flocks (McCaffery and Gill 2001, McCaffery et al. 2006). It is unknown if birds breeding in the NPR-A are undergoing reproductive failure.

3.3.5.7 Raptors

Raptors are birds of prey that include falcons, hawks, eagles, and owls. The snowy owl and gyrfalcon are the only raptors known to overwinter in the NPR-A; all others migrate south to overwinter (Johnson and Herter 1989). The Colville River and adjacent wetlands in the planning area provide the North Slope's single most important area of raptor nesting habitat, with significant proportions of several Alaskan species' populations occupying bluffs and cliffs along its shoreline. In the NPR-A, cliff-nesting raptors are more common inland than near the coast. Arctic peregrine falcon, gyrfalcon, golden eagle, and rough-legged hawk are regular breeders on the cliffs along the Colville and other rivers in the Reserve. Merlins also nest in small numbers along larger rivers in the southern portion of the NPR-A. The golden eagle (a BLM sensitive species) occurs regularly in the planning area. The snowy owl, short-eared owl (a BLM sensitive species), and northern harrier are widely dispersed and nest irregularly throughout the planning area.

In contrast to many bird species, there has been scientific research conducted on raptor populations in the planning area. A long-term dataset for peregrine falcons, gyrfalcons, and rough-legged hawks nesting along the Colville River was initiated by Cade (1960) in 1952, following that, efforts were sporadic until 1978, after which surveys had been conducted yearly by the U.S. Fish and Wildlife Service with support from BLM through 2005, then by BLM alone in 2008, and again by the U.S. Fish and Wildlife Service with support from the BLM in 2011. Aerial surveys were conducted in 1977 and repeated in 1999 over all appropriate raptor habitat in the NPR-A in order to compare cliff-nesting raptor populations between the two periods and assess the present distribution, abundance, and degree of recovery of the arctic peregrine falcon population in the region. The National Audubon Society has designated the Colville River, with its tributaries the Kikiakarak and Kogosukruk rivers, downstream from the confluences of the Ipnavik and Etivluk rivers, to Ocean Point as an Important Bird Area of Continental Importance[16] (see Map 3.3.5-4). The Secretary of the Interior also designated the vast majority of the Colville River as the Colville River Special Area, in part due to its importance to raptors (see section 3.3.9 for more information on this designation).

Arctic Peregrine Falcon

The arctic peregrine falcon (*Falco peregrinus tundrius*) is one of three subspecies of peregrine falcons that occur in Alaska. Arctic peregrine falcons migrate into Alaska each year and breed north of the Brooks Range and on the Seward Peninsula (White 1968). Arctic peregrine falcons are highly migratory and winter from the southern United States south to Argentina (Cade et al. 1971). Arctic peregrine falcons are in Alaska from about mid-April to mid-September. Nesting begins in mid-May on the Arctic Slope, and the young fledge from the end of July to mid-August. Immature peregrines use coastal habitats in some areas from late August through mid-September (Johnson and Herter 1989). Approximately 250 pairs of arctic peregrine falcons nest in Alaska each year (Swem 2007). Declines in falcon populations resulted in the subspecies being listed in 1970 as endangered under the Endangered Species Conservation Act of 1969. Upon passage of the Endangered Species Act (ESA) of 1973, peregrine falcons (including arctic peregrine falcons) were listed as endangered throughout their range. The population declines in the 1960s were correlated with DDE (dichlorodiphenyldichloro-ethylene; parent compound DDT dichlorodiphenyltrichloroethane) concentrations in eggs, resulting in eggshell thinning and hatching failure (Cade et al. 1971). Peregrine falcon populations rebounded after the chemical was banned in the U.S., and these birds were removed from the ESA listing in 1994. Monitoring of the population was required under the ESA regulations until 1999 (59 FR 50796 [October 5, 1994]) after which the BLM has continued to monitor the population. Peregrine falcons are currently on the U.S. Fish and Wildlife Service's Birds of Conservation Concern list for the Arctic Plains and Mountains bird conservation region. The National Audubon Society has designated the high-density raptor nesting areas along the Colville River as an Important Bird Area (Lower Colville River Important Bird Area) of continental importance[17] (see Map 3.3.5-4).

Research initiated in 1952 (Cade 1960) detailed the initial distribution and abundance of peregrine falcons in the Colville River drainage. Studies have continued since the 1950s, providing a unique and valuable dataset that documents the decline and subsequent recovery of this species from synthetic organic chemicals (White et al. 2002). This valuable dataset has documented the decline and recovery of this species along the Colville River, from a low of 14 pairs in 1973 and a high of 62 pairs in 1998 (White et al. 2002). The Colville River Special Area contains the North Slope's single most important area of raptor nesting habitat. Aerial surveys conducted in 1977 and 1999 documented peregrine falcons nesting within the NPR-A on many river drainages including the Colville, Etivluk, Fish Creek, Titaluk, Ikpikpuk, Ipnavik, Kiligwa, and Utukok rivers (Ritchie et al. 2003) (see Map 3.3.5-20). Peregrine falcons are found on cliffs adjacent to rivers and will use a variety of substrates for nesting including ledges and platforms on rocky outcroppings, at the brink of a cliff or on the nose of a steep earth bluff, and occasionally in old nests built by rough-legged hawks (White and Cade 1971). All nest sites are closely associated with river habitats (White and Cade 1971), and no pairs or single birds were recorded at off-river outcrops in a 1999 aerial survey (Ritchie et al. 2003). The most frequently used nesting habitats for falcons in the Colville River Special Area are along the lower Colville River (see Map 3.3.5-20), especially along shale banks and rock cliffs.

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[16] http://iba.audubon.org/iba/viewSiteProfile.do?siteId=3097&navSite=state

[17] http://iba.audubon.org/iba/profileReport.do?siteId=3097&navSite=search&pagerOffset=70&page=3

Monitoring within the Colville River Special Area has been mostly conducted by on-the-ground observers (Ritchie et al. 2003) who complete two surveys per year. The first survey is to determine the number of birds that occupy nesting sites, and the second is to ascertain productivity (number of young produced). From 1952–2005, a mean of 41 pairs per year were detected within the survey area, with 58 territorial pairs detected during the 2008 survey. The boundary of the survey area has changed slightly over the years of the survey, but the core area (which is completely contained within the Colville River Special Area and the Lower Colville River Important Bird Area) begins in the south on the Colville River at the mouth of the Etivluk River, continues north to Ocean Point on the Colville River and includes the lower 5 kilometers of the Kogosukruk and Kikiakrorak rivers. Occupancy data from 1980 through 2008 documents an increased population; with high of 62 pairs in 1998 and low of 21 pairs in 1980. The surveys of nesting success indicate similar trends to those of occupancy. The average percent of pairs during the entire study period successful at producing at least one young to fledging is 53 with a high of 72 percent in 1990 and a low of 29 percent in 1973. Total productivity rates through the study period averaged 52 young per year (high of 100 in 1990 and low of 9 in 1973). The average number of young produced for each pair is 1.3 when all available years of data are considered, 1.4 for 1980–2005, and 1.1 for 1995–2005.

Aerial surveys conducted in 1977 and 1999 were designed to assess the abundance and distribution of the arctic peregrine falcon and other raptor species within the NPR-A. The aerial survey area encompassed all cliff habitat in the NPR-A, excluding the area covered by the on-the-ground observers (Ritchie et al. 2003). These surveys compared cliff-nesting raptor population levels between the two periods and assessed the present distribution, abundance, and degree of recovery of the peregrine falcon population in regions of the NPR-A which are outside those of the ground surveys (Ritchie et al. 2003). The 1999 aerial survey documented that arctic peregrine falcons occupied 67 sites in the NPR-A. In comparison, in 1977 only 4 of 61 potential sites in the area surveyed were occupied. Eighty-four percent of all pairs observed in 1999 produced at least one young, and for the entire study area, productivity averaged 2.3 young per successful pair and 2.0 young per pair for all pairs. Of the 67 sites found occupied in the 1999 aerial survey, 17 were located within the Colville River Special Area in areas that are not covered by the on-the-ground surveys.

Nine sites were located on the main stem of the Colville River between the Etivluk River mouth and the southern border of the Colville River Special Area.

Arctic peregrine falcons nesting in the Colville River Special Area are extremely versatile in their choice of prey (White and Cade 1971). Most of the falcons' diet consisted of shorebirds and passerines, with up to 15 percent of the passerines being "willow-inhabiting" birds such as the gray jay, thrushes, warblers and three species of finches (White and Cade 1971). Mammals were found to be infrequent in the diet of arctic peregrine falcons, with 1 to 4 percent of all prey consisting of mammals (White and Cade 1971). A minimum of 47 species of birds have been found to be prey items of arctic peregrine falcons, and the frequency of any given prey species may change annually (White et al. 2002).

In many parts of the world, peregrine falcons frequently use manmade structures for nesting (e.g., cut banks for roadbeds, electric-transmission towers, oil pipelines, and a variety of buildings, churches, and bridges in metropolitan centers) (White et al. 2002, Yokel 1999). On the Arctic Coastal Plain, in areas of current oil and gas development, some raptors including falcons nest on buildings and pipelines. These new nesting substrates increase risks of collisions with vehicles or powerlines, and incineration in flare pits (Yokel 1999). The arctic peregrine falcon can be susceptible to disturbance by humans on foot (Ritchie 1987, Palmer et al. 2001). A study conducted in 1985 and 1986 demonstrated that response of nesting peregrine falcons to humans varied with distance between the human and the falcon (Ritchie 1987). The most severe reactions occurred when activities were near or above the nest, such as could be expected from recreational activities; subsistence hunting; falconry; and geological, paleontological, archeological, and fish and wildlife fieldwork (Ritchie 1987). In addition, Palmer et al. (2001) conducted a study of peregrine falcons on the Tanana River, which documented that nesting success during incubation and chick brooding could be disproportionately affected by factors like disturbance. The authors showed that disturbance may shift activities away for thermoregulation of eggs and young chicks and towards territorial defense. These two studies clearly show that human presence in the vicinity of a peregrine nest site elicits severe reactions from the birds and may lead to decreased nest success. Ritchie (in Yokel 1999) states that perhaps the most serious impact to raptors from oil and gas exploration and development may be disturbance of nesting birds and potential subsequent loss of productivity.

Wintering grounds and portions of migratory routes of arctic peregrine falcons lie in areas outside of the North Slope, including areas within the U.S. and several other countries. Regulated and non-regulated development in these areas can impact habitats important for falcons. Various types of contaminants and toxins from industrial and agricultural activities can enter either terrestrial or marine environments and affect mortality or reproductive success. Oil spills have been an obvious source of bird mortality at numerous locations around the world. Development along migration corridors and in wintering areas may result in habitat loss or disturbances that add to the cumulative impacts on peregrine falcon populations. The level of significance of these losses is not well understood. Little is known about how climate change would affect the arctic peregrine falcon. The habitat and prey base could change, but the direction, magnitude, and timeframe are not known.

Gyrfalcon

Within the NPR-A, the gyrfalcon is an uncommon species on the coastal plain, but is a fairly common nesting species in the foothills of the Brooks Range and on cliffs and bluffs along the Colville River. Gyrfalcons initiate nesting in early spring and young fledge by mid-August (Swem et al. 1994). Gyrfalcons prey on rock and willow ptarmigan. The abundance of ptarmigan has an impact on the potential yearly reproductive output of pairs and on the winter movements of individuals (Clum and Cade 1994). Gyrfalcons are nonmigratory if their prey remains abundant throughout the winter (Clum and Cade 1994). If prey becomes scarce some birds may move south through Canada to the northern U.S during winter (Terres 1982).

Nigro and Ritchie (2004) reported 12 nests along the Colville River between the mouth of the Etivluk River and Ocean Point during ground based surveys in 2003. A subsequent survey in 2008 located 14 gyrfalcon nesting territories along the same survey area (BLM, unpublished data). During aerial surveys conducted in 1999 and 1977 (see "Peregrine Falcon" section for description of the study area), Ritchie et al. (2003) detected evidence of gyrfalcon use at 41 sites in 1999 compared to at 29 sites 1977. Most of the gyrfalcon nest sites (83 percent) were located in the southern foothills of the planning area. Sites on the Kiligwa, Kuna, and Utukok rivers accounted for more than half of all recorded nest sites (Ritchie et al. 2003). Gyrfacons were primarily found nesting on rock cliffs and shale banks associated with the floodplains of area rivers (Ritchie et al. 2003) and generally use larger cliff habitats than peregrine falcons and rough-legged hawks. Gyrfalcons have been found nesting on the above ground portion of the Trans-Alaska Pipeline System pipeline approximately 150 kilometers south of Prudhoe Bay in an old common raven nest (Ritchie 1991).

The greatest threat to gyrfalcons in the NPR-A is likely to be from climate change. As gyrfalcons are resident in the NPR-A and depend on a limited prey source, any changes to their prey species (ptarmigan) populations or year round environmental conditions are likely to produce negative effects to the population. Some of the effects may be seen through range constriction, changes in diet and breeding phenology, shrinking foraging habitats, thermal stress, and extreme weather events affecting survival and nesting, and interspecific competition. Two recent studies incorporating climate models predicted substantial declines in the ranges of gyrfalcons and one of those studies additionally predicted greater fragmentation of ranges and reduced overlap between the ranges of gyrfalcons and ptarmigan (Watson et al. 2001). Oil and gas development in the planning area may cause disturbance to nesting birds. A study conducted in the Yukon showed that birds were always disturbed by helicopter overflights at 150 meters above nest site, were less frequently disturbed at 300 meters, and were not disturbed at 600 meters. Birds were more disturbed by lateral approaches than approaches from above (Platt 1976). Disturbance from overflights did not result in abandonment or reduced productivity, but disturbed birds were less likely to reuse same nest site following year (Platt 1976).

Rough-legged Hawk

Rough-legged hawks are the most abundant and widespread cliff-nesting raptor in the NPR-A (Ritchie et al. 2003). Rough-legged hawks winter from southern Canada south to the southern United States (Terres 1982, Palmer 1988, Johnsgard 1990). The center of abundance for rough-legged hawks in northern Alaska is the Colville River drainage

(Bechard and Swem 2002). The size and productivity of breeding populations of rough-legged hawks has been shown to vary considerably among years (Kuyt 1980, Poole and Bromley 1988, Swem 1996). Ground-based studies on the Colville River showed that the number of pairs occupying territories varied from 53 to 106 (mean 90) over an 11-year period (Swem 1996) and that 77 territories were located in 2008, the most recent year of the survey (USDOI BLM, unpublished data). Aerial surveys conducted in 1999 and 1977 (see "Peregrine Falcon" section for description of the study area) identified 182 locations of rough-legged hawk nests, of which 66 percent were occupied in 1999, twice as many as were located in aerial surveys conducted in 1977 (Ritchie et al. 2003). Eighty percent of the rough-legged hawk nest sites located during the 1999 aerial survey were found along the cliffs in southern foothills of the NPR-A (Ritchie et al. 2003). Sixty-nine percent of all nests were located on six drainages including the upper Colville River. The northern foothills of the Reserve contained 16 percent of all nest sites and 4 percent of nest sites were observed on the Arctic Coastal Plain in the northern portion of the planning area (Ritchie et al. 2003). Rough-legged hawks were primarily found nesting on the upper Colville, Etivluk, Ipnavik, Kiligwa, Utukok, and Kuna rivers (Ritchie et al. 2003).

A variety of nest site substrates was used by rough-legged hawks including shale bluffs, rock cliffs, scree and talus slopes (Ritchie et al. 2003, Swem 1996). Voles and lemmings have been shown to be important components of the diet of rough-legged hawks during the breeding season, although they have also been found to eat arctic ground squirrels, hares, and birds (White and Cade 1971, Swem 1996). If changes in climate lead to a decrease in the prey population, decreases in rough-legged hawk populations are possible. Various types of contaminants and toxins from industrial and agricultural activities can enter either terrestrial or marine environments and affect bird mortality or reproductive success. Oil spills have been an obvious source of bird mortality at numerous locations around the world. Development along migration corridors and in breeding or wintering areas may result in habitat loss or disturbances that add to the cumulative impacts on rough-legged hawk populations. Rough-legged hawks are known to exploit manmade structures for nesting including buildings along the Dalton Highway in Alaska (Bechard and Swem 2002, Ritchie 1991).

Other Raptors

Most raptors on the North Slope are cliff-nesting species, but ground-nesting raptors in the NPR-A include snowy and short-eared owls (see section 3.3.8.2, "Special Status Species"), merlins, and northern harrier. These species breed irregularly across the NPR-A, and are most common during years with high rodent populations. Snowy owls (*Bubo scandiacus*) have been found breeding in the planning area during years of high rodent populations, but during years of low microtine populations, they may be absent (Parmelee 1992). Northern harriers occasionally breed in the northern foothills of the Brooks Range (Johnson and Herter 1989). During the 2008 ground survey for raptors in the Colville River Special Area, three merlin territories were located although no nests were found (USDOI BLM, unpublished data). There are no recent records of distribution or abundance available for these species in the planning area.

3.3.5.8 Ptarmigan

Willow and rock ptarmigan (*Lagopus lagopus, L. muta*) are found in the planning area. Ptarmigan are ground-nesting birds in the grouse family that remain in the NPR-A as year-round residents (Johnson and Herter 1989). Liebezeit and Zack (2006, 2007, 2008) reported nesting densities of willow ptarmigan to be 3.1 nests/square kilometer (2006), 1.3 nests/square kilometer (2007) and 3.1 nests/square kilometer (2008) at their study site south east of Teshekpuk Lake. They did not encounter any rock ptarmigan nests on their study area, although adult rock ptarmigan were seen. Johnson et al. (2003) reported higher nest densities for willow ptarmigan than for rock ptarmigan in the planning area near the Alpine field. Brooks Range passes are important movement corridors and use areas for ptarmigan in the late winter (Irving 1960), and concentrations of ptarmigan have been noted along the Utukok River in spring (USDOI 1978). Willow ptarmigan occupy areas with patches of dense vegetation, especially where willow or birch shrubs are abundant and form thickets, often along areas of forest and road edges; however, they are also found on open tundra (Hannon et al. 1998, Johnson and Herter 1989 [and references therein]). Willow ptarmigan in the planning area may undergo a short migration in the winter to occupy habitats, which afford it shelter from the wind (Holder and Montgomerie 1993, Irving 1960). Rock ptarmigan are typically found occupying areas of Arctic and alpine tundra at elevations greater than those of the willow ptarmigan (Gabrielson and Lincoln 1959, Holder and Montgomerie 1993, Irving 1960). Rock ptarmigan are found nesting in dry rocky habitats, and in hummocky areas of wet sedge meadows (Holder and Montgomerie 1993). Rock ptarmigan spend the entire year in the same area with only local movements occurring in the winter (Holder and Montgomerie 1993, Johnson and Herter 1989).

Passerines

Most passerines found in the NPR-A winter in temperate and tropical regions in the Americas or southern Asia (USDOI BLM and Minerals Management Service 1998). They generally arrive on the North Slope from late May to early June and remain until mid to late August (Johnson and Herter 1989). The common raven (*Corvas corax*) is the only resident species in this group. With the exception of the common raven and Say's phoebe (*Sayornis saya*; both cliff-nesting species), the passerines breeding in the planning area are tundra or shrub-nesting species (Cade and White 1973). Aerial surveys flown in 1977 (King 1979) determined that the highest densities (193 birds per square kilometer) of passerines were noted within 20 miles of Barrow and in the southern foothills and mountains of the planning area. Over 97 percent of all passerines detected over the entire extent of the aerial survey in 1977 were lapland longspurs (*Calcarius lapponicus*) (USDOI 1978).

Lapland longspurs are the most common species nesting across the Reserve. The average nest density on study plots in the northeastern portion of the NPR-A was 20.7 nests/square kilometer (Burgess et al. 2003). Liebezeit and Zack (2006, 2007, 2008) found lapland longspurs to be the highest density nesting passerine species (42.5, 40.0, 42.5 nests/square kilometer over the 3 years of their study) at their study area southeast of Teshekpuk Lake. Other species, including savannah sparrow (*Passerculus sandwichensis*), redpoll (*Acanthis flammea*), snow bunting (*Plectrophenax nivalis*), and yellow wagtail (*Motacilla tschutschensis*) may be fairly common to abundant breeders in the northern portion of the planning area. Snow buntings are very common in areas of development where they find nesting sites in crevices of buildings, pipelines, and other man-made structures. In the southern portion of the NPR-A passerine species richness is highest in riverine and upland shrub habitats (White and Cade 1971). Lapland longspur, common redpoll, yellow warbler (*Dendroica petechia*), Arctic warbler (*Phylloscopus borealis*), savannah sparrow, American tree sparrow (*Spizella arborea*), white-crowned sparrow (*Zonotrichia leucophrys*), fox sparrow (*Passerella iliaca*), redpoll, snow bunting, bluethroat (*Luscinia svecica*), northern wheatear (*Oenanthe oenanthe*), and yellow wagtail may be fairly common breeders in the southern portion of the Reserve (Derksen et al. 1981, Irving and Paneak 1954, Kessel and Cade 1958, Maher 1959, Reed 1956). Likely less common but present in the southern portion of the planning area are American robin (*Turdus migratorius*), seen at Otuk Creek, Iteriak Creek, and Kuna River by BLM's Mike Kunz (USDOI BLM, personal communication); Say's phoebe (Cade and White 1973); northern wheatear; and two species listed as species of concern by Partners in Flight, Smith's longspur (*Calcarius pictus*) and gray-cheeked thrush (*Catharus minimus*). Smith's longspur is also on the U.S. Fish and Wildlife Service's Birds of Conservation Concern list for the Arctic Plains and Mountains Bird Conservation Region.

Common Raven

Common raven, though not abundant, is the only permanent resident passerine in the NPR-A, and is commonly found only in the southern portion of the planning area where nesting opportunities are much greater than in the northern portion of the planning area. Common ravens occurred historically in discrete areas such as along the Colville River bluffs, and bred primarily in the foothills and mountains of the Brooks Range (White and Cade 1971) where they nested on cliffs (Johnson and Herter 1989).

As the largest-bodied of all passerines, this raven is widely known for being a scavenger on animal carcasses and human garbage. It is also a predator of mammals and birds. The common raven has also been implicated as a causative factor in the declines of several threatened and endangered species including desert tortoise (*Gopherus agassizii*), California condor (*Gymnogyps californianus*), marbled murrelet (*Brachyramphus marmoratus*), and least tern (*Sterna antillarum*) (Boarman and Heinrich 1999).

A study of nesting ravens conducted on the Colville River upstream of Umiat in 2006 and 2007 found that all nests were located on cliffs with little or no vegetation below them, immediately adjacent to the river, and at an average height of 12 ± 5 meters above the water (Powell and Backensto 2008). Most nests (75 percent) were oriented to southerly aspects, and all had roof ledges that provided roughly 30 to 70 percent cover from above. A breeding male raven captured and outfitted with a satellite transmitter in 2007 used an area of approximately 2,395 square kilometers with a maximum movement of 60 kilometers away from the nest during the period that the transmitter was active.

Before human development on the Arctic Coastal Plain, common ravens were uncommon because of the lack of suitable nesting habitat. Liebezeit and Zack (2006, 2007, 2008) considered common ravens to be a rare bird at their study site southeast of Teshekpuk Lake where there are no man-made structures suitable for nesting. However, over the past several decades common raven nesting habitat (buildings and other man-made structures) on the Arctic Coastal Plain has become more common, although it is unknown to what extent the population may have taken advantage of this increase (Hohenberger et al. 1994).

No long-term surveys adequately assess common raven population status on the Arctic Coastal Plain; however, an increase in population is inferred from increased numbers counted at the North Slope Borough landfill in Prudhoe Bay and the expansion of its range onto the Arctic Coastal Plain (Day 1998). Some individuals overwinter on the Arctic Coastal Plain near human food sources; their overwinter survival rate is believed to be higher than it would be without access to anthropogenic food resources. Recent changes in garbage handling and in the operation of the Prudhoe landfill have likely reduced but not eliminated access to anthropogenic food resources. Changes in landfill practices were associated with a roughly 50 percent decline in raven counts at the Prudhoe landfill (Hechtel, cited in Day [1998]). In recent years, common ravens have been reported nesting at the Alpine field (Johnson et al. 2003). As their numbers have increased, common ravens are suspected to have become important predators of tundra-nesting birds on the Arctic Coastal Plain; however, no direct measurement of their impact is available (Day 1998).

3.3.5.9 Birds and Climate Change

Bird habitats worldwide are threatened by climate change, though species for which breeding is restricted to the Arctic regions may be the most vulnerable to climate change. Many bird species present in the NPR-A have circumpolar distributions with breeding ranges that vary from high latitude tundra only, to widely distributed across Alaska, to those with associated sub-Arctic and temperate breeding areas for which the NPR-A is the northern extension of their breeding range. The climate change scenario presented in this document (Scenarios Network for Alaska Planning 2010) predicts that for the rest of the 21st century temperature and precipitation will increase but that longer, warmer summers will increase evapotranspiration so that there will actually be less moisture available to plants and the potential for many shallow streams, ponds, and wetlands in the Arctic to dry out under a warming climate is increased by the loss of permafrost. These shallow systems depend on snowmelt as their primary source of water, with rainfall gains often negated by evapotranspiration during the summer. Evaporation from these shallow waterbodies is very likely to increase as the ice-free season lengthens. Hence, the water budget of most lake, pond, and wetland systems is likely to depend more heavily on the supply of spring meltwater from winter precipitation to produce a positive annual water balance, and these systems are more likely to dry out during the summer (Arctic Climate Impact Assessment 2004)

The following discussion touches only on very broad changes in bird habitats and associated food resources that might occur if the modeled future trends are fairly accurate. The processes that are likely to have the greatest effect on bird populations in the planning area are (Martin et al. 2009): (1) abundance and distribution of surface water, (2) vegetation community changes, (3) invertebrate community changes, and (4) coastal process and habitats.

The abundance and distribution of surface water is of crucial importance to Arctic birds as the aquatic and semi-aquatic habitats of the planning area support very large numbers of birds. Increased summer temperatures could lead to the conversion of aquatic habitats into dryer habitat types resulting in a loss of not only habitat quantity but also habitat quality in terms of potential decrease in food resources (invertebrate and plant). This loss of quantity and quality would likely lead to changes in bird distributions which might in turn lead to increased competition for limited resources and associated decreases in productivity.

Section 3.3.1.4 of this document outlines the changes that may occur in vegetation communities if climate change predictions are correct. These include changes in the species composition of the tundra leading to increases in shrub extent and height with increased grasses and sedges in some areas, at the expense of mosses and lichens. Warmer soil temperatures are likely to increase thermokarst, and increases in sea level may inundate low-lying tundra areas, increasing salt marsh, aquatic, and wet tundra vegetation types and erosion of coastal bluffs (Arctic Climate Impact Assessment 2004). Significant changes in plant communities of the NPR-A may be expected especially in the southern foothills and mountains. Increases in shrub height and extent could have varying effects on the bird community depending on the location of the change and the species composition of the area. There could be a positive effect for shrub associated passerines, ptarmigan, and their predators, and a negative effect in terms of productivity and abundance for wetland-adapted species if their habitat is reduced by the encroachment of shrubs. Shorebirds, for example, may initially benefit because of earlier snowmelt and warmer summers with more stable food availability, but in the longer term overgrowing of the tundra with shrubs and trees will probably reduce their breeding habitats significantly (Meltofte et al. 2007). Changes in plant phenology due to warming temperatures may result in an increase in plant biomass, but a decrease in plant quality in relation to forage for birds. A reduction in forage quality for herbaceous birds may lead to a decrease in egg and chick production and a reduction in body condition of those birds that use the NPR-A during molt and pre-migration periods. There is also the potential that the timing of emergence of high quality forage and the greatest energy needs of the birds might be offset if the timing of vegetation growth changes independently of the timing of the nutritional needs of the birds.

Impacts to the bird community may occur if warmer spring temperatures advance snowmelt, which is closely associated with insect emergence, and result in changes in the timing and patterns of insect emergence and peak abundance to which the birds may not be able to compensate. This potential disconnect between invertebrate abundance and bird nutritional needs may cause decreases in bird productivity and survival (Tulp and Schekkerman 2008) and have a negative effect on bird body condition during the molt and pre-migration periods resulting in birds in poorer condition during the fall migration and winter periods. Redistribution of water into newly created thermokarst areas may result in an increase in invertebrate productivity and lead to an increase in the productivity, abundance, and distribution of some species of birds. However, if climate change causes drying of currently saturated soils and shallow wetlands including drained lake basins, then invertebrate populations may decrease leading to a decrease in the productivity, abundance, and distribution of some species of birds.

Loss of barrier islands and changes to the salinity and temperature regimes of protected coastal lagoons due to climate change could have negative effect on those birds that use these areas for breeding (common eiders, gulls, terns), molting (many waterfowl species), and pre/post migration staging (loons, waterfowl and shorebird species). The increase in coastal erosion that is predicted to occur due to climate change has the potential to significantly decrease the terrestrial habitat within the goose molting area of the planning area resulting in a decrease in the foraging, nesting, brood-rearing and staging habitats for a number of different waterfowl and shorebird species. Increases in sea level and storm surges may affect coastal habitats including mud flats, wet sedge coastal tundra, and salt-killed tundra. Changes to tundra habitats could cause changes in the quantity and quality of habitat for brood-rearing brant and staging habitat for some waterfowl and shorebirds.

3.3.6 Terrestrial Mammals

The mammals of the NPR-A use all three physiographic provinces of Alaska's North Slope (see section 3.2.4 and Map 3.2.4-1). Habitats within the NPR-A have been subjected to limited disturbance in the past and are considered to be in a mostly natural and nearly pristine condition given the roadless nature of the area, difficulty in accessing the area, and the low numbers of both residents and permitted activities occurring there. The NPR-A is centrally located in Game Management Unit 26A (Map 3.3.6-1), and covers most of that unit.

Terrestrial mammals occurring in the NPR-A (Hull 1994) include caribou, muskox, moose, Dall sheep, grizzly bear, gray wolf, wolverine, Arctic fox, red fox, and small mammals such as the arctic ground squirrel, ermine, least weasel, lemming, voles, and shrews (USDOI BLM and Minerals Management Service 1998). These species occur across the North Slope and in many other parts of Alaska. These and other terrestrial mammals that may be present in the NPR-A are listed in Table 3-19. Polar bears occur in the NPR-A in terrestrial and marine habitats, but they are generally considered marine mammals (e.g., they are regulated under the Marine Mammal Protection Act) and have been listed as threatened under the Endangered Species Act (U.S. Fish and Wildlife Service 2008). Polar bears are described in section 3.3.8, "Special Status Species."

Only those mammalian species considered important as a subsistence resource, economically important to the region, designated with sensitive species status, or whose populations may potentially be affected by development scenarios analyzed in Chapter 4 of this document are addressed in detail in this chapter. Present in the NPR-A, but excluded from this description are weasels, snowshoe hares, shrews and several species of rodents (e.g., marmots, ground squirrels, lemmings, and voles). This IAP/EIS briefly discusses the distribution and habitat use of the remaining species that are common or occur regularly in the planning area. More detailed species and life history accounts can be found in 1998 Northeast IAP/EIS (USDOI BLM and Minerals Management Service 1998; III-B-39) and Northwest IAP/EIS (USDOI BLM and Minerals Management Service 2003; III.B.5).

3.3.6.1 Caribou (*Rangifer tarandus*)

Caribou herds are defined by the geographic location of their calving areas because cow caribou have high fidelity to calving areas and usually return each year following seasonal migrations (Skoog 1968, Cameron and Whitten 1979, Davis et al. 1986). Genetic data and field observations indicate that fall and winter ranges of different herds sometimes overlap, and that this may result in some interbreeding between herds (Skoog 1968, Whitten and Cameron 1983, Prichard et al. 2001, Cronin et al. 2003).

Table 3-19. Mammal species known or suspected to occur in the NPR-A

Common name	Scientific name	Iñupiaq name	Abundance[1]
Large mammals			
Arctic fox	*Alopex lagopus*	Qusrhaaq/tibiganniaq/ qujhaaq	Common
Caribou	*Rangifer tarandus*	Tuttu	Abundant
Dall sheep	*Ovis dalli*	Imnaiq	Uncommon
Gray wolf	*Canis lupus*	Amabuq	Uncommon
Grizzly (brown) bear	*Ursus arctos*	Akjaq	Uncommon
Moose	*Alces alces*	Tiniikaq/tuttuvak/titiniika	Uncommon
Muskox	*Ovibos moschatus*	Umifmak/imummak	Uncommon
Red fox	*Vulpes vulpes*	Kavviaq/kayuqtuq	Uncommon
Wolverine	*Gulo gulo*	Qavvik/qapvik	Uncommon
Small mammals			
Arctic ground squirrel	*Spermophilus parryii*	Siksrik	Abundant
Barren-ground shrew	*Sorex ugyunak*	Ugrugnaq	Common
Brown lemming	*Lemmus trimucronatus*	Aviffaq	Common
Collared lemming	*Dicrostonyx groenlandicus*	Qixafmiutauraq	Common
Ermine (short-tailed weasel)	*Mustela erminea*	Itibiaq/tibiaq	Common
Least weasel	*Mustela nivalis*	Naulayuq	Uncommon
Northern red-backed vole	*Evotomys rutilus*	Avieeaq	Common
Singing vole	*Microtus miurus*	—	Common
Snowshoe hare	*Lepus americanus*	Ukalliuraq/ukalliq	Rare or accidental
Tundra shrew	*Sorex tundrensis*	Ugrufnaq	Uncommon
Tundra vole	*Microtus oeconomus*	Avieeaq	Uncommon
Other mammals			
Coyote	*Canis latrans*	Amabuuraq	Rare or accidental
Lynx	*Lynx canadensis*	Niutuuyiq/niutuiyiq/ nuutuuyiq	Rare or accidental
Marten	*Martes americana*	Qapvaitchiaq	Rare or accidental
Mink	*Mustela vison*	Tibiaqpak	Rare or accidental
Porcupine	*Erethizon dorsatum*	Ixuqutaq/qifabluk	Rare or accidental
River otter	*Lontra canadensis*	Pamiuqtuuq	Rare or accidental

1. Abundant = species present in great numbers in an area; common = species very likely to be seen in a given area, but in fewer numbers than an abundant species; and uncommon = species is regularly present but is seen infrequently. Species designated as rare or accidental are at the limit of their range. (Source: Table modified from Phillips Alaska, Inc. 2001).

There are four caribou herds in Arctic Alaska: the Teshekpuk Caribou Herd; Map 3.3.6-2), the Central Arctic Herd (Map 3.3.6-3), the Western Arctic Herd (Map 3.3.6-4), and the Porcupine Caribou Herd. Caribou of the Teshekpuk Caribou Herd, Western Arctic Herd, and Central Arctic Herd have a portion of their ranges in the NPR-A (Maps 3.3.6-2 through 3.3.6-4). Since the NPR-A is not used by the Porcupine Caribou Herd, this herd is not discussed further (USDOI BLM and Minerals Management Service 2003). The Western Arctic Herd and Teshekpuk Caribou Herd use habitats adjacent to and extensively within the NPR-A (Map 3.3.6-4 and Map 3.3.6-2). Scatter plots for Western Arctic Herd and Teshekpuk Caribou Herd satellite collars show that caribou from these herds are relatively discreet on the North Slope during summer, although they frequently mix on winter range in the central Brooks Range (Dau 2001). The Central Arctic Herd primarily uses habitats to the east of the NPR-A (Map 3.3.6-3). While only a small portion of Central Arctic Herd range use is within the NPR-A, there is the potential that off-site facilities, such as pipelines, could be constructed in areas used more frequently by this herd as a result of actions within the NPR-A.

Each of the three NPR-A herds is discussed in separate sections below. To reduce redundancy, most information on general caribou biology is discussed only in the "Teshekpuk Caribou Herd" section even though it also applies to the other two herds.

Teshekpuk Caribou Herd

Sources of information on the Teshekpuk Caribou Herd include White et al. (1975); Davis and Valkenburg (1978, 1979); Silva (1985); Dau (1986); Carroll (1992, 1995, 1997, 1999, 2001, 2003a); Philo et al. (1993); Brower and Opie (1996, 1997); Whitten (1997); Cronin et al. (1998); USDOI BLM and Minerals Management Service (1998, 2003); Noel (1999, 2000); Ballard et al. (2000); Kellyhouse (2001); Prichard et al. (2001); Jensen and Noel (2002); National Research Council (2003); Prichard and Murphy (2004); Noel and George (2003); Person et al. (2007); Yokel et al. (2009). This is not meant to be an exhaustive list of publications on the Teshekpuk Caribou Herd, but presents the primary information without being redundant.

Population Status and Range. The Teshekpuk Caribou Herd was recognized as a separate herd from the Western Arctic Herd and Central Arctic Herd in the mid-1970s (Davis and Valkenburg 1978). The primary range of the Teshekpuk Caribou Herd is the North Slope west of the Colville River, with the peripheral range sometimes extending as far south of the Brooks Range as the Nulato Hills and as far east as the Arctic National Wildlife Refuge. Most of the herd's annual use is in the northern portion of the NPR-A (Map 3.3.6-2). In 1990, a cooperative satellite-tracking project began to evaluate annual movements, seasonal ranges, and habitat use by Teshekpuk Caribou Herd caribou. Results of this study indicated that the herd was more widely distributed with more variable movements than previously thought (Prichard et al. 2001, Prichard and Murphy 2004). During spring and fall migrations, some satellite-collared Teshekpuk Caribou Herd animals have moved through the southern NPR-A. Even more have traveled during fall migration along the Chukchi Sea coast through the NPR-A and on to the south. Winter ranges of some Teshekpuk Caribou Herd animals extend east to the Dalton Highway and south to the Seward Peninsula.

Visual estimates of the number of animals in the Teshekpuk Caribou Herd were recorded in 1978 (3,000 to 4,000 caribou), and 1981–1982 (4,000 caribou; BLM unpublished data). In 1984, the first photocensus of the Teshekpuk Caribou Herd counted 11,822 caribou. Other photocensus estimates in 1985 (13,406 caribou), 1989 (16,649 caribou), and 1993 (27,686 caribou) documented a steady increase in the Teshekpuk Caribou Herd. These results yield average annual increases of 7.1 percent from 1984 to1989 and 14 percent from 1989 to 1993 (Carroll, 1999). This period was followed by a decrease in the herd estimate in 1995 (25,076 caribou). The estimate again increased in 1999 (28,627 caribou) and in 2002 (45,166 caribou). The decline evident in 1999 may have been due to the previous severe winter (Prichard et al. 2001). Alternatively, it may be that the 1999 photocensus resulted in an underestimate, and that the herd in fact gradually increased from the mid 1990s to 2002 (Carroll 2005c).

Due to poor weather and caribou distribution, the Teshekpuk Caribou Herd was not photocensused between 2002 and 2008. An unusual eastward movement of a portion of the herd during the winter of 2003–2004 resulted in a significant mortality event and it was feared this may have adversely affected the Teshekpuk Caribou Herd population. Also, emigration among North Slope caribou herds occurs, but is poorly documented (Person et al. 2007). Nonetheless, a photocensus conducted in 2008 resulted in a minimum estimate of 64,106 Teshekpuk Caribou Herd animals, yielding an average annual growth rate of 5.9 percent from 2002–2008 (Parrett 2010). A census in 2011, however, produced an estimate of about 55,000 for the Teshekpuk Caribou Herd (Parrett, personal communication, 2012), a 5 percent annual decline from the previous estimate.

Migration. To take advantage of seasonally available forage, caribou migrate between their calving areas and summer and winter ranges. If movements are greatly restricted, caribou are more likely to over-graze their habitat, possibly leading to a population decline. Caribou diets shift seasonally and depend upon the availability of forage within seasonal ranges. In general, the winter diet of caribou consists predominantly of lichens, with a shift to vascular plants during the spring (Thompson and McCourt, 1981). Composition of plant fragments in caribou fecal pellets collected in the winter range of the Western Arctic Herd averaged 83 percent lichen (Jandt et al. 2003). However, when Teshekpuk Caribou Herd caribou winter near Teshekpuk Lake, where relatively few lichens are present, they likely consume more sedges and vascular plants than is typical of the Western Arctic Herd caribou wintering in lichen-rich ranges south of the Brooks Range.

Spring migration to traditional calving grounds consistently provides highly nutritional forage to lactating females during calving and nursing periods, which is critical for the growth and survival of newborn calves. Eriophorum buds (tussock cotton grass) appear to be very important in the diet of lactating caribou cows during the calving season (Thompson and McCourt 1981, Eastland et al. 1989), while orthophyll shrubs (especially willows) are the predominant forage during the post-calving period (Thompson and McCourt 1981). The availability of high quality and high quantity desired forage species, which apparently depends on temperature and snow cover, probably affects specific calving locations and calving success. Kellyhouse (2001) looked at habitat selection by the Western Arctic Herd and Teshekpuk Caribou Herd based upon rates of increase in green plant biomass. She found that the Western Arctic Herd selected habitats with high relative green plant biomass (i.e., high forage quantity) during calving and at peak lactation, while in contrast the Teshekpuk Caribou Herd selected habitats with high rate of increase in biomass (i.e., high forage quality).

Most Teshekpuk Caribou Herd caribou begin migrating from winter ranges across northern Alaska to the Teshekpuk Lake area during May (Prichard and Murphy 2004). By early June, most of the pregnant cows move into calving areas around the lake. After calving, most Teshekpuk Caribou Herd caribou move north of Teshekpuk Lake, traveling through the narrow corridors between the lake and the Kogru River to the east or the lake and Smith Bay to the west. Most of the herd uses the area along the coast for insect relief. After the insect-relief period, Teshekpuk Caribou Herd caribou spread out and can be found across the North Slope coastal plain, primarily within the NPR-A. Fall movements of the Teshekpuk Caribou Herd are variable among individual caribou and years. Most Teshekpuk Caribou Herd caribou winter on the NPR-A coastal plain in most years, but occasionally some or most of the herd winters in other places such as the eastern coastal plain, the central Brooks Range, or northwestern Alaska as far south as the Nulato Hills.

Calving Grounds. Calving takes place in the spring, generally from late May to late June (Hemming 1971). The calving grounds of the Teshekpuk Caribou Herd are primarily in the northeastern portion of the NPR-A near Teshekpuk Lake (Map 3.3.6-5). Calving grounds may shift gradually over years or change abruptly because of environmental conditions, so the areas shown in these figures may not fully represent future concentrated calving areas. If snowmelt occurs in late spring, more caribou calve south of the lake than if snowmelt occurs in early spring (Carroll et al. 2005). Kelleyhouse (2001) reported that the size of the Teshekpuk Caribou Herd annual calving grounds ranged between 938 and 1,861 square miles. From 1990–2002, calving by the Teshekpuk Caribou Herd was concentrated southeast and northeast of Teshekpuk Lake (Prichard and Murphy 2004). Caribou were reported to calve south and west of the lake before 1978 (Davis and Valkenburg 1978). Carroll (2001) reported that in 2000 calving occurred all around Teshekpuk Lake and that more calves than usual were seen south and west of the lake. Aerial transect data (1999–2001) agree with telemetry data (1990–2004) that during the calving period, caribou use the entire area around Teshekpuk Lake (Carroll, G., 2007a, personal communication; Carroll et al. 2005). Inclusion of the most recent satellite tracking data (Map 3.3.6-5) confirms this. In general, Teshekpuk Caribou Herd distribution during calving has been quite predictable. Between 1994 and 2008, the areas immediately to the northeast, southeast, and south of Teshekpuk Lake received the most consistent and concentrated use for calving (Parrett 2010). However, the 2010 calving season (see below) differed from this pattern, with several collared cows calving between the Meade and Ikpikpuk rivers (Map 3.3.6-5) and even some to the west of the Meade River. The calving distribution in 2011 was intermediate between 2010 and the 1994–2008 "norm." Whether or not the Teshekpuk Caribou Herd will return to this "normal" pattern in the near future remains to be seen.

The importance of the Teshekpuk Lake area to calving caribou is emphasized by observed calving success in abnormal years. The return of pregnant cow caribou to the area can be delayed in years when the caribou migrate further away during winter, or when snow-pack is deeper than normal, and/or spring melt-off is later than normal. When their return to the Teshekpuk Lake area is delayed, more cows than usual calve along the way and this in turn results in lower than average calving success (Carroll et al. 2005). During 1996–97 most of the herd migrated much farther south than usual and many cows arrived late to the Teshekpuk Lake area. Only 8 of 21 collared caribou were found in the "lake area" during calving time and 6 (75 percent) of these calved successfully. The "lake area" was defined by Carroll et al. (2005) as that area unavailable for leasing, available but without surface activity, or protected by "special caribou stipulations" in the Record of Decision for the Northeast NPR-A (USDOI BLM and Minerals Management Service 1998). Of the other 13 collared cows, only 1 (8 percent) calved successfully for an overall successful calving percentage of 33 percent. In 2001, heavy snow and a late snow melt-off slowed the migration and only 16 (44 percent) of 36 collared cows calved successfully. Calving success for collared cows that did make it back to the "lake area" in 2001 was higher (88 percent) than ones found outside the "lake area" (10 percent). The June, 2010, calving distribution again experienced a late spring and the distribution of cows spread west nearly to Icy Cape. There was a concentration of cows on the Topagoruk River south of Admiralty Bay (Parrett, L., 2010, personal communication). Only 12 collared cows, of which only 5 had calves (42 percent), were in the "lake area" whereas 35 collared cows, 17 with calves (49 percent), were outside the "lake area". This most unusual of years in terms of calving distribution was also unique in that calving success was apparently better outside the "lake area." Nonetheless, 2010 continued the trend of lower overall calving success when the majority of cows are not near the lake; 47 percent of collared cows calved successfully in 2010 whereas the long-term average (1994–2009) is 63 percent success. Data on 2011 calving success are still being analyzed at this time.

The evolutionary significance of the calving grounds to caribou may relate directly to the avoidance of predation on caribou calves, particularly by wolves (Bergerud 1974, 1987). Caribou calves are very vulnerable to wolf predation, as indicated by the documented account of surplus predation by wolves on newborn calves (Miller et al. 1985). By migrating north of the tree line, caribou leave the range of the wolf packs, since wolves generally remain on the caribou winter range, or in the foothills, or along the tree line during the wolf-pupping season (Heard and Williams 1991, Bergerud 1987). By calving on the open tundra, the cow caribou also avoid ambush by predators. Snow-free tundra also helps camouflage the newborn calf from other predators, such as golden eagles (Bergerud 1987). Sequential spring migration, first by cows and later by bulls and the rest of the herd, is believed to be a strategy for optimizing the quality of forage as it becomes available from snowmelt on the Arctic tundra (Whitten and Cameron 1980). The earlier migration of parturient cow caribou to the calving grounds also could reduce forage competition with the rest of the herd during the calving season. Russell et al. (1993) found that staggered migration allowed both parturient females and bulls to maximize body weight by late June.

During calving and immediate post-calving periods, cow/calf groups are most sensitive to human disturbance. Many cow/calf groups join to form increasingly larger groups, foraging primarily on the emerging buds and leaves of willow shrubs and dwarf birch (Thompson and McCourt 1981).

Summer Distribution and Insect-relief Areas. Insect-relief areas become important during the late June to mid-August insect season (Lawhead 1997) when caribou behavior and movements are greatly influenced by harassment from mosquitoes and oestrid flies (White et al. 1975). Insect harassment can reduce foraging efficiency and increase physiological stress (Cameron et al. 1993). Rates of caribou movement are highest at this time of the year (Prichard and Murphy 2004). In July and August, caribou attain their highest degree of aggregation. Depending on the size of the herd involved, caribou may be found in continuous groups of hundreds to tens of thousands, and portions of a herd may be found throughout the summer range. Insect harassment reduces foraging efficiency and increases physiological stress (Reimers 1980). Caribou use various coastal (Teshekpuk Caribou Herd and Central Arctic Herd) and upland (Western Arctic Herd and to a lesser extent Central Arctic Herd) habitats for relief from insects, including areas such as sandbars, spits, river deltas, some barrier islands, mountain foothills, snow patches, and sand dunes where stiff breezes prevent insects from concentrating. Summer is also the time when caribou cows must concentrate on foraging to meet the energy demands of lactation and still gain enough weight to enable conception in the fall (Cameron et al. 1993). Caribou aggregations move frequently between insect-relief areas along the Arctic coast (Western Arctic Herd, Central Arctic Herd, and especially the Teshekpuk Caribou Herd) and foraging areas.

The Teshekpuk Caribou Herd summer range is between Barrow and the Colville River. In early July, Teshekpuk Caribou Herd caribou generally aggregate to the north and southeast of Teshekpuk Lake for insect (mosquito) relief (Prichard et al. 2001, Prichard and Murphy 2004; Map 3.3.6-6). Other caribou use habitats as far east as Fish Creek. The Teshekpuk Lake area is important as summer range because of prevailing winds and proximity to the coast, river deltas, and lake edge that provide insect-relief habitat and adjacent forage. The relatively narrow land areas on the east and west sides of the Teshekpuk Lake are important travel corridors for caribou moving between habitats north and south of the lake (Person et al. 2007, Yokel et al. 2009). Map 3.3.6-6 also shows an area of concentration southwest of Teshekpuk Lake during the mosquito season. Yokel et al. (2009) hypothesize that this area is used by caribou for foraging when lower temperatures and higher winds reduce the level of harassment by mosquitoes. When winds abate and temperatures rise, mosquito levels increase and the caribou return to the areas north and southeast of the lake.

In late July and early August, the primary insect pests of caribou are oestrid flies, which lay their eggs in caribou nasal passages or under their skin. Caribou behavior to avoid these flies differs from mosquito avoidance behavior, when caribou gather in large aggregations and move to the coast. During fly harassment, caribou tend to disperse and the Teshekpuk Caribou Herd spreads out to the east and west of the lake and moves farther inland (Map 3.3.6-7). During this period caribou tend to seek insect-relief habitats such as sand dunes, relatively barren ridges, sandy stream channels and the sandy margins of partially drained lake beds, such as the Pik Dunes about 30 kilometers south of Teshekpuk Lake (Hemming 1971, Philo et al. 1993).

Fall and Winter Range Use and Distribution. The movement and distribution of all three caribou herds over their respective winter ranges reflect their need to avoid predators and to protect themselves from wind and snow conditions (snow depth and density) that greatly influence the availability of winter forage (Henshaw 1968, Bergerud 1974, Bergerud and Elliot 1986). The number of caribou using a particular portion of the winter range varies greatly from year to year. Distribution of preferred winter forage (particularly lichens), weather conditions, and predation pressure affect winter distribution and movements (Roby 1980, Miller 1974, Bergerud 1974).

During fall (August–September), many Teshekpuk Caribou Herd caribou have been observed around Teshekpuk Lake and east to Fish Creek. In fall migration, some Teshekpuk Caribou Herd caribou again use the narrow corridors east and northwest of the lake (above). Prior to 1990, The Teshekpuk Caribou Herd was believed to reside year-round in the Teshekpuk Lake area (Davis et al. 1982). However, satellite collar data collected since 1990 indicate that some animals travel south to winter in locations beyond the NPR-A (Prichard and Murphy 2004; Map 3.3.6-2). During most years since 1990, the majority of Teshekpuk Caribou Herd caribou have wintered on the coastal plain of the NPR-A, especially around Atqasuk and southeast of Teshekpuk Lake, but portions of the herd may also winter in a variety of other places. In some years, portions of the herd have migrated as far as the Nulato Hills to the south, Point Hope to the west, or the central Brooks Range near Anaktuvuk Pass to the southeast (Prichard and Murphy 2004). In the winter of 2003–2004, a significant portion of the herd moved to the Arctic National Wildlife Refuge to the east (Carroll 2007d).

Harvest. The Teshekpuk Caribou Herd has a smaller annual range than the Western Arctic Herd in most years, but is nonetheless very important in the subsistence economies of some North Slope villages.

It has recently been estimated that 99 percent of the caribou harvest in Barrow during June through September (when 80 percent of the Barrow harvest occurs) comes from the Teshekpuk Caribou Herd and only 1 percent from the Western Arctic Herd (Parrett et al. 2009). Subsistence harvest of the Teshekpuk Caribou Herd is year-round, with most occurring between June and September by residents of Anaktuvuk Pass, Atqasuk, Barrow, Kaktovik, Nuiqsut, Point Hope, and Wainwright. It is difficult to determine precise numbers for Teshekpuk Caribou Herd harvest because not all hunters report their harvest and because most villages harvest caribou from more than one herd. However, by examining village subsistence harvest studies and using radiotelemetry data to determine the percentage of caribou that are in village hunt areas during harvest season, a reasonable estimate can be made of Teshekpuk Caribou Herd harvest.

Approximately 2,500 Teshekpuk Caribou Herd caribou in 1999–2000, 2,760 during 2000–2001, and 4,463 in 2002–2003, were harvested by residents of North Slope villages (Carroll 2005c); harvests of 3,996 in 2004–2005 and 4,129 in 2005–2006 were estimated in following years (Carroll 2007d). The 2006–2007 and 2007–2008 harvests were estimated at 4,829 and 4,102 caribou, respectively (Parrett 2010). This is an annual harvest rate of 6.6 to 7.5 percent of the herd at its current population level. Harvest of the Teshekpuk Caribou Herd by sport hunters is generally low and mostly confined to the Colville River drainage.

Western Arctic Herd

Population Status and Range. In the early 1970s, the Western Arctic Herd population was estimated at 243,000 animals. By 1976, it had declined to an estimated 75,000 animals, but from 1976 to 2003 the herd grew substantially. Census data from 1996 and 1999 resulted in population estimates of 463,000 and 430,000 caribou, respectively (Dau 2003b). The latter census was considered an underestimate due to poor conditions for a photocensus that year. This was supported in 2003 when a census returned an estimate of 490,000 caribou (Dau 2005b). Following the 2003 census, the Western Arctic Herd declined to an estimated 377,000 caribou in 2007 (Dau 2007b), possibly due to severe winter icing events (Dau, J., 2008, personal communication), and to 348,000 in 2009 (Alaska Department of Fish and Game News Release, March 24, 2011). A census completed in 2011 resulted in the current estimated populations size of 325,000 (Alaska Department of Fish and Game News Release, July 3, 2012). The estimates from 2007 and 2009 were within each other's margins of error (Dau, J., 2010, personal communication). With the 2011 census a downward trend is evident, but the herd is still very large and managed sustainably.

The Western Arctic Herd ranges over about 140,000 square miles in northwestern Alaska, from the Chukchi coast east to the Colville River, and from the Beaufort Sea coast south to the Kobuk River. In winter, the range extends as far south as the Seward Peninsula and Nulato Hills, and as far east as the Sagavanirktok River north of the Brooks Range and the Koyukuk River south of the Brooks Range (Map 3.3.6-4). This range includes the entire NPR-A, which the Western Arctic Herd uses primarily during summer in the calving and insect-relief seasons (Dau 2005b), although in recent years up to several thousand Western Arctic Herd animals have summered on the Seward Peninsula (Dau 2007b). The concentrated wintering area, where most of the Western Arctic Herd spends December through April, is south of the NPR-A and the Brooks Range, in the area of the Nulato Hills and eastern Seward Peninsula (Dau 2005b). Map 3.3.6-4 represents a generalized summary of all forms of relevant data available (Dau 2003b, 2006a), including VHF and satellite collars on male and female caribou, observations of tens of thousands of unmarked caribou by biologists while flying surveys, observations by local residents and hunters, and contextual information such as snow characteristics, behavior, density of groups, and general direction of travel. This is a qualitative method of data summary, and is not repeatable (i.e., would not necessarily provide the same result if done more than once).

Migration. Spring migration of pregnant female caribou from the overwintering areas to the calving grounds begins in April (Dau 2007b). The northward movement through the Brooks Range at this time and during fall migration occurs along a broad front (Figure 3 in Dau 2005b). Often the most direct routes are used; however, certain routes may be used during calving migrations because they tend to be snow-free or snow-shallow corridors (Lent 1980). Bulls and barren females generally migrate later, with some remaining on winter ranges until June (but see above). Severe weather and deep snow can delay spring migration, with some calving en route. This occurred with the Western Arctic Herd in the spring of 2000, when approximately 22 percent of the radio-collared cows with calves were observed south of the Brooks Range (Dau 2001). Cows calving en route usually proceed to their traditional calving grounds (Hemming 1971), although calf survival may diminish.

Caribou migrate seasonally between their calving areas and summer and winter ranges to take advantage of seasonally available forage. Earth cover in the Western Arctic Herd calving grounds is dominated by moist dwarf-shrub and moist low-shrub vegetation classes (Kelleyhouse 2001), and Western Arctic Herd animals select these classes over the less abundant dry-prostrate shrub and moist graminoid classes. However, Kuropat (1984) reported that Western Arctic Herd cows forage heavily on the new flower buds of Eriophorum vaginatum (tussock cottongrass) that emerge immediately after snow melt. For other North Slope caribou herds, including the Teshekpuk Caribou Herd, tussock cottongrass buds appear to be very important in the diet of lactating caribou cows during the calving season (Thompson and McCourt 1981, Eastland et al. 1989, Kelleyhouse 2001). For both herds, orthophyll shrubs (especially Salix [willows]) are the predominant forage during the post-calving period, also referred to as the summer, insect-relief period (Thompson and McCourt 1981, Kuropat 1984). There is a short period in late June, between calving and insect seasons, when Lupinus arcticus (lupine) flowers are important to the Western Arctic Herd (Kuropat 1984).

The vegetation classes used in the studies above do not correspond directly to classes in USDOI BLM (2002), presented in the "Vegetation" section of this chapter (see section 3.3.1). The moist dwarf-shrub vegetation class of Kelleyhouse (2001) corresponds to parts of the tussock tundra and dwarf shrub classes of USDOI BLM (2002). Both of the latter two classes may have a significant component of tussock cottongrass. The moist low-shrub vegetation class of Kelleyhouse (2001) corresponds more directly to the low shrub class of USDOI BLM (2002). "Vegetation," section 3.3.1, describes the abundance and distribution of the tussock tundra, and dwarf shrub and low shrub classes in the NPR-A.

Studies of Western Arctic Herd winter diet have not been conducted in the NPR-A. In the primary Western Arctic Herd winter range south of the Brooks Range mountains, up to 70 to 80 percent of the winter diet of caribou is composed of lichen (Jandt et al. 2003). The availability of lichen in the NPR-A is discussed in "Vegetation," section 3.3.1. Winter grazing by this large caribou herd has resulted in a significant decrease (greater than 50 percent) in lichen availability in a Buckland Valley study area south of the Brooks Range over the last three decades (Jandt et al. 2003, Joly et al. 2006).

Calving Grounds. Map 3.3.6-8 depicts the primary calving ground for the Western Arctic Herd from 1987–2010. Since the mid-1970s, and even as early as 1960 (Dau 2007b) the Western Arctic Herd primary calving area has been in the Utukok Uplands, in southwestern NPR-A (Dau 2001 and 2003b). However, from 1987–2006, calving appears to have been more dispersed. In some years, especially 1994–1996, calving extended further west, beyond the western boundary of the NPR-A (Dau 1999, Kelleyhouse 2001). During 1987–2006 the calving range also spread northeast into the Meade River drainage (Dau 1999, 2007b; Map 3.3.6-8), although surveys were done late in 1987 and cows had probably moved west by the time they were located. In 1990, calving appeared to be early so surveys conducted at the normal time likely had the same bias as in 1987. Calving concentrations may shift gradually over years or change abruptly due to environmental conditions and population size (Hinkes et al. 2005). Typically, most pregnant cows reach the calving grounds by late May, but severe weather and deep snow can delay spring migration with some caribou calving en route. Because of the among-year variability in location of concentrated calving, it is important to maintain unfettered access to all of the primary calving ground and to provide an adequate buffer around that area for years when unusual environmental conditions delay migration. The unusually broad distributions of Western Arctic Herd caribou cows in 2000 (Kelleyhouse 2001, Figure 9) and 2001 due to late snowmelt (Dau 2003b) illustrate this need.

Map 3.3.6-4, Map 3.3.6-8, and Map 3.3.6-9 show slightly different interpretations of calving and insect-relief (summer) habitats due to the different data and methods used in their preparation. Map 3.3.6-8 represents a quantitative, repeatable (kernel) analysis of locations from VHF and satellite collars on maternal caribou for the calving grounds (Dau 2006a). This calving grounds map shows the smallest area containing certain percentages of calving activity. The depiction of insect-relief habitat (Map 3.3.6-9), is also a quantitative, repeatable analysis. It uses number of collar movements from all collared caribou during the insect season through each 200 square mile grid rather than using kernel analysis. The methods used in Maps 3.3.6-8 and 3.3.6-9, as opposed to those used in Map 3.3.6-4, can show patterns of distribution and variability in distribution among years, but are based on small sample sizes and use only actual location information.

Summer Distribution and Insect-relief Areas. Insect-relief areas (Map 3.3.6-9) are important during the late June to mid-August insect season. Western Arctic Herd caribou use various coastal (outside of the NPR-A) and upland habitats for relief from insects, including sandbars, spits, river deltas, some barrier islands, mountain foothills, snow patches, and sand dunes. In general, these are areas where substrate characteristics and stiff breezes prevent insects from concentrating. Dau (2003b) provides a description of the general movements of the Western Arctic Herd from calving to insect-relief areas.

For many years, the Western Arctic Herd has exhibited a consistent pattern of movement during the summer (Dau 2003b, 2005b, 2007b). By mid-June, after calving in the Utukok Uplands, cow/calf groups begin to move west into the Lisburne Peninsula west of the NPR-A. In late June when the mosquitoes begin to emerge, any bulls and non-maternal cows that have not already done so also arrive on the western North Slope and join the cow/calf groups. In early July, mosquito harassment intensifies and oestrid flies begin to emerge, causing most of the herd to form into large aggregations, sometimes numbering greater than 200,000 individuals, in the western DeLong Mountains and western North Slope. During late July and early August as insect harassment continues, they move rapidly back east toward the Howard and Anaktuvuk passes through southern NPR-A. Any human activities or developments in this area at this time would affect virtually the entire herd and ultimately the communities that rely on them as a subsistence resource.

As insects diminish in early to mid-August, the caribou disperse. Some move further west and north onto the North Slope, going as far as Cape Lisburne and Barrow, while others remain in the foothills and Brooks Range mountains. Radio telemetry data indicate that the vast majority of the Western Arctic Herd uses the western North Slope and Brooks Range during the summer, as described above. In recent years, however, several thousand caribou (primarily bulls and immature cows) have summered on the Seward Peninsula (Dau 2003b, 2007b).

Fall and Winter Range Use and Distribution. The fall migration begins as early as mid-August for some Western Arctic Herd animals and extends until caribou reach their winter ranges in early to late November. Movement south through the Brooks Range at this time occurs along a broad front (Figure 5 in Dau 2007b,). Caribou not only use valleys between mountaintops when crossing over the divide, but also move along ridges and mountainsides. During winter, migratory movements cease and the animals become relatively sedentary until spring migration in April (Hemming 1971).

The winter range of the Western Arctic Herd has changed over time and varies annually. Before the mid-1970s, a substantial portion of the Western Arctic Herd wintered north of the Brooks Range, including in the NPR-A, or near Wiseman and Anaktuvuk Pass. Since the mid-1970s, the primary winter range of the Western Arctic Herd has been south of the Brooks Range along the northern fringe of the boreal forest (Dau 2001). The area identified as winter range on Map 3.3.6-4 represents areas where most of the herd has wintered in most years since the mid-1980s (Dau 2005b). During winters of heavy snowfall or severe ice crusting, caribou may overwinter within the mountains or on the North Slope (Hemming 1971). Even during normal winters, when most of the herd migrates south of the Brooks

Range, some Western Arctic Herd caribou overwinter in the NPR-A and other North Slope locations. From zero to 29 percent of radio-collared Western Arctic Herd caribou wintered on the North Slope south of the coastal plain and west of the Dalton Highway from 1983–2005 (Dau 2005b). This area includes the NPR-A.

Harvest. The Western Arctic Herd, because of its large size and large annual range, is important to the subsistence economies of many rural villages. About 40 communities with 13,000 people live within its range (Steinacher 2010). Estimates of rural subsistence harvest based on annual per capita harvest by community (Dau 2003b) were 14,000 Western Arctic Herd caribou in the 2002–2003 regulatory year and about 11,000 in the 2003–2004 regulatory year (Dau 2005b). A statistical model was also used in following years with resulting harvest estimates of 15,000 for the 2004–2005 year and 14,000 for 2005–2006 (Dau 2007b). Comparisons between the two methods showed differences of only 0.4–2.4 percent. For more information on the subsistence harvest, see "Subsistence," section 3.4.3. The Western Arctic Herd is also hunted by people who reside outside the herd's range. These non-local hunters harvested at least 697 Western Arctic Herd caribou during the 2002–2003 regulatory year and at least 549 in the following year (Dau 2005b). These numbers may increase as more non-local hunters shift their efforts from the Mulchatna Herd in southwest Alaska to the Western Arctic Herd (Dau 2007b).

Central Arctic Herd

Sources of information on the Central Arctic Herd include White et al. (1975); Roby (1978); Cameron and Whitten (1979); Whitten and Cameron (1980); Gavin (1983); Carruthers et al. (1984); Lawhead and Curatolo (1984); Dau (1986); Jakimchuk et al. (1987); Fancy et al. (1989); Pollard et al. (1996a, b); Smith (1996); Noel et al. (1998); USDOI BLM and Minerals Management Service (1998, 2003); Lenart (1999b, 2003); Lawhead and Johnson (2000); Murphy and Lawhead (2000); Noel and Olson (1999a, b); Olson and Noel (2000); Prichard et al. (2001); Burgess et al. (2002); Lawhead and Prichard (2002); Phillips Alaska, Inc. (2002); Douglas et al. (2002); Lawhead et al. (2003); and National Research Council (2003).

Population Status and Range. The range of the Central Arctic Herd extends from the Colville River to the Canning River, and from the Beaufort Sea coast to the southern slope of the Brooks Range (Map 3.3.6-3; Lenart 1999). During summer, portions of the Central Arctic Herd may range short distances west of the Colville River into the NPR-A and east of the Canning River into the Arctic National Wildlife Refuge. Large movements of the Central Arctic Herd west of the Colville River into the NPR-A are unusual (Lawhead et al. 2006).

The Central Arctic Herd was estimated at approximately 5,000 caribou in 1975 and increased to approximately 23,444 in 1992. The Central Arctic Herd declined to 18,093 in 1995 (Lenart 1999) and then increased again to 19,730 in 1997, 27,128 in 2000 (Lenart, 2003), and 31,857 in 2002 (Lenart 2007b). The most recent photocensus conducted in the summer of 2008 documented approximately 67,000 caribou (Lenart 2010).

Migration. The Central Arctic Herd migrate between winter range in the central Brooks Range east of the NPR-A and summer range on the Arctic Coastal Plain. In general, parturient cows arrive on the ACP between early May and early June, calving occurs between the last week of May and the second week of June, and bulls arrive by early July.

A gradual southward fall migration generally occurs after the insect-relief season ends in mid-August.

Calving Grounds. The Central Arctic Herd calves between the Colville and Canning rivers to the east of the NPR-A, within 100 miles of the Beaufort Sea, with calving concentrated in areas east and west of the Sagavanirktok River. In the 1980s, calving was relatively common in the Kuparuk oil field. Calving data in the Colville-Kuparuk region from 1993 to 2002 showed that the greatest calving densities were approximately 12 miles south of the Kuparuk oil field with the proportion of Central Arctic Herd calving in this latter area apparently higher in the 1990s than in the 1980s (Lenart 2003). Lower densities of calving have been reported within and adjacent to the Kuparuk and Milne Point oil fields. Calving has occurred there since the oil fields were built in 1980–1981, but the proportion of the herd calving in and near the oil fields, especially within 4 kilometers of roads, has decreased since the mid-1980s (Cameron et al. 2005).

Summer Distribution and Insect-Relief Areas. The summer range of the Central Arctic Herd most commonly encompasses the area between the Canning and Colville rivers and from the coast inland to the foothills (Lenart 2007b). When harassed by insects, caribou of the Central Arctic Herd typically use coastal areas, river deltas and bars, and non-vegetated habitats such as gravel roads and pads for relief from insects. During periods of harassment by insects, large groups of caribou have been observed along the Beaufort Sea coastline, near Franklin Bluffs, on oil field roads and gravel pads, and on the deltas of the Canning, Kadleroshilik, Kuparuk, Sagavanirktok, Shaviovik, and Staines rivers. Aerial surveys have documented Central Arctic Herd caribou moving west into the Colville River Delta and the NPR-A. The largest such movement (more than 10,000 caribou) occurred in July 2001. During these brief movements west of the Colville River, there may be some mixing of the Central Arctic Herd with the Teshekpuk Caribou Herd (Lenart 2007b) During periods with little or no insect activity on the ACP, caribou move back inland (Lawhead 1988).

Winter Range Use and Distribution. In early fall, most Central Arctic Herd caribou move south from the summer range to the foothills of the central Brooks Range to areas around Toolik Lake, Galbraith Lake, Accomplishment Creek, Ivishak River, and the upper Sagavanirktok River (Map 3.3.6-3; Lenart 2003). Some animals migrate to the south side of the Brooks Range, especially the upper Chandalar River drainages (Lenart 2007b). Surveys during March 2001 and February 2002 located caribou north and south of the Brooks Range and east and west of the Dalton Highway/Trans-Alaska Pipeline System corridor. As many as several hundred Central Arctic Herd caribou may overwinter on the ACP, some within the Kuparuk oil field. Fall and winter ranges of the Central Arctic Herd, Teshekpuk Caribou Herd, and Western Arctic Herd may overlap (Lenart 1999, 2003, 2007b).

Harvest. Local subsistence hunters from Nuiqsut and Kaktovik and non-local hunters harvest about 800 to 900 Central Arctic Herd caribou each year (Lenart 2007b, 2010). These numbers may soon rise because the Alaska Board of Game increased the allowable sport harvest from one to five caribou per day in 2010. Non-locals hunt mostly along the Dalton Highway.

3.3.6.2 Muskoxen (*Ovibos moschatus*)

Muskoxen occurred throughout northern Alaska, but were extirpated from what is now the NPR-A in the mid-1800s (Hone 1934, Smith 1989). Muskoxen were reestablished by translocation to Nunivak Island near the western Alaska coast in 1935 (Spencer and Lensink 1970), to Barter Island and the Kavik River near today's Arctic National Wildlife Refuge in 1969 (Jingfors and Klein 1982), and to the west of the NPR-A near Cape Thompson in 1970 and 1977 (Smith 1989).

After 1969, muskox numbers in northeastern Alaska increased and their range expanded to the Colville River on the west and beyond the Babbage River on the east (Reynolds 1998, Lenart 2007c). This population gradually expanded west into the NPR-A. Alaska Department of Fish and Game began doing regular surveys of muskoxen in the central North Slope in 1997 after mixed-sex groups had become established there (Carroll, G., 2007, personal communication). Up to this time, only transitory lone bulls, but no mixed-sex groups, had been observed in the NPR-A. In 1997, Alaska Department of Fish and Game estimated 279 muskoxen to be between the Colville River and the Arctic National Wildlife Refuge, with 81 of those being in the Itkillik Hills as a breeding population about 20 miles east of the Colville River, but none were found along the Colville River itself (Johnson et al. 1996, Lenart 2007c).

In 1998, five muskoxen were observed along the Ikpikpuk River within the NPR-A (Carroll, G., 2007, personal communication); Alaska Department of Fish and Game opened an emergency hunt at the request of local residents and muskoxen were not seen in this area again until two were observed in 2000. Also in 1998, two groups of 16 each were observed along the Colville River. In 1999, 96 muskoxen were observed in the western part of Game Management Unit 26B, between the Colville River and the Dalton Highway (Lenart 2007c). In 2001, three groups were found along the Colville River and a group of five on Fish Creek within the NPR-A. At the time these were the only known breeding groups within or near the NPR-A (Carroll, G., 2007, personal communication).

Whether the group near Fish Creek survived is not certain, but in 2004 a group of 11 muskoxen was observed not too far away near Inigok. This group moved to the Kogru River and then to lower Fish Creek in 2005, and included nine adults and six calves, so by this time breeding muskoxen were known to occur in the NPR-A. By May, 2007, this group had increased to 21 adults and 6 calves, but later that month they were found about 25 miles offshore on sea ice for reasons unknown. By mid-June, 13 (presumed) cows from this group had made it back to land north of Teshekpuk Lake, but no calves or bulls were identified in this group at that time. This group of cows was seen in October 2007, between Teshekpuk Lake and the Lonely DEW-Line site. Either one of the 13 cows was actually a young bull (misidentified from the air), or a bull later joined the group, because when this group was next seen in 2009 it contained 13 adults and 3 calves (Carroll, G, 2010, personal communication). The following year, in 2010, there were 15 adults and 8 calves. For the last 2 years, they have been located northwest of Teshekpuk Lake and east of Smith Bay.

The Cape Thompson population ranges from the mouth of the Noatak River to Corwin Bluff within 15 to 20 miles of the Chukchi Sea coast (Dau 2007a), which is well west of the NPR-A boundary. This population grew at about an 8 percent annual rate through 1998. Since 1998, the population has appeared stable. The 2007 population was estimated at 347 total animals (Dau 2007a). In addition to this core range, small groups of from 1 to 4 individuals, usually transitory bulls, have occasionally been seen along the Chukchi Sea coast as far northeast as the vicinity of Barrow (Carroll, G., 2002, Personal communication). An incidental sighting in 2006 of 12 muskoxen near Meat Mountain in southwestern NPR-A, including 5 cows, 5 calves, and at least 1 adult bull, suggested that muskoxen from this western population may be emigrating from their core range near the Chukchi Coast to new areas (Dau 2007a). This hypothesis was further corroborated in following years when, during moose trend counts, muskoxen were observed in the upper Colville River Watershed between the Ipnavik and Etivluk rivers (Carroll, G., 2010, personal communication). This group included 4 adults and 2 calves in 2008, 21 adults and 6 calves in 2009, and 26 adults and 7 calves in 2010. Although it is not certain, it is suspected that this group originated from the Cape Thompson population. In addition, mixed-sex groups were observed on the uppermost Colville River near its western headwaters in 2009 (24 adults and 7 calves) and on the Kokolik River just west of the NPR-A boundary in 2008 (19 adults and 4 calves; see Map 3.3.6-10).

The most important habitats for muskoxen in the Colville River delta, just outside of the NPR-A, have been determined to be riparian, upland shrub, and moist sedge-shrub meadows (Johnson et al. 1996). Studies in the late 1970s (USDOI BLM 1978), before any muskoxen had returned to the NPR-A or most of the rest of Alaska's North Slope, estimated best potential habitat for muskoxen (Map 3.3.6-10; irregular, gray shaded polygon). A more recent effort to describe potential muskox habitat in the NPR-A was completed by Danks (2000), based on habitats used by muskoxen east of the NPR-A at that time, and Earth cover classifications derived from satellite imagery. This analysis described winter and summer habitats separately (Map 3.3.6-10 and Map 3.3.6-11), concluding that suitable summer habitat exists primarily in lower-lying drainages and wetter areas, and suitable winter habitat in drier, more rugged, exposed areas. The results for winter had some similarities to the 1978 study, with the most suitable habitat occurring in an east-west belt across central NPR-A, but the most suitable summer habitats were further north in the coastal plain. Unfortunately, none of these maps of potential habitat corresponds very well with the muskox sightings mentioned above. Either muskox habitat in the NPR-A remains to be adequately described, or muskox colonization in the NPR-A has not yet progressed to the point where habitat preferences are being effectively displayed.

Favored habitat just west of the NPR-A includes wind-blown ridges during the winter and riparian areas during the summer. When snow depth is greater than 12 inches, muskoxen move to areas where snow cover is minimal such as exposed ridges. Vegetation in these areas is typically sparse. During the winter, muskoxen survive on body-fat reserves and minimize movement to conserve energy. In the summer, forage is plentiful and muskoxen build fat reserves (Dau 2003a). Coastal winds tend to diminish snow depths on exposed ridges west of the NPR-A during the winter and keep ambient temperatures lower during the summer (Dau 2007a). The quality and quantity of winter forage in this area is low and may have limited the growth rate of the population. One hypothesis for the failure of the western population to expand further east and establish itself in the Arctic Foothills physiographic province of the NPR-A may be the distance from the coast and its associated winds. This may result in deeper snow cover in the NPR-A as compared to coastal areas, making both movements and foraging very difficult in winter. However, the 2008–2010 sightings of muskoxen between the Ipnavik and Etivluk rivers suggest this hypothesis, if true, does not apply throughout the inland foothills area. Another possible explanation for slow population growth is illegal harvest, of which the magnitude is unknown.

3.3.6.3 Moose (*Alces alces*)

Moose have been documented on the North Slope since the 1800s and breeding populations have been reported on the western North Slope since the 1920s (Coady 1980) and established there since about 1940 (Carroll 2004b). Game Management Unit 26A covers the western North Slope, including the entire NPR-A (Map 3.3.6-1). The best time to survey this moose population is in the late winter when they are still concentrated along rivers and there is ample daylight. Aerial census surveys have been conducted at this time every 3 to 7 years since 1970 (Carroll 2004b). Between 1970 and 1991, the Game Management Unit 26A population increased slowly (1970: 1,197; 1977: 1,234; 1984: 1,403; and 1991: 1,488). Between 1991 and 1995 however, the population declined by about 50 percent, to 718, with annual trend counts indicating a further sharp decline in 1996. Trend counts indicate that the population decline began in 1992/1993 and continued until 1996 (Carroll 2000).

Natural mortality appears to have been the major cause of the population decline. Fall composition surveys in 1993–1995 indicated low calf survival while spring trend counts from 1993 to 1997 indicated high adult mortality and a 75 percent population decline (Carroll 2004b). The decline was probably the result of a combination of several factors including poor nutrition, disease, high predator populations, weather, and competition with snowshoe hares (Carroll 1998b).

The population began to increase in 1997 with improved calf survival, and continued to increase from 1998 through 2000, with an apparent population increase of 21 percent annually during that period (Carroll 2000). A survey in 2005 indicated 998 moose (Carroll 2008b). The same survey in spring, 2008, resulted in a count of 1,116 moose, but calf survival the following summer was very low, with only 6 percent of the population being calves (Carroll, G., 2008a, personal communication). The total population numbers showed some stability through 2008, but then calf production decreased dramatically and trend counts in 2009 and 2010 indicated yet another precipitous population decline (Carroll, G., 2010, personal communication). About 20 wolves were seen during the 2010 survey; apparently predation was at least part of the cause for the decline (Parrett, L., 2010, personal communication).

Moose are widely distributed during the summer, ranging from the northern foothills of the Brooks Range to the Arctic Coast. Moose occur at low densities on the coastal plain, and at somewhat higher densities in the foothills. As snow accumulates during fall, moose move to riparian corridors of large river systems (Map 3.3.6-12), where they concentrate in winter. The largest winter concentrations of moose occur in the inland portions of the Colville River drainage, along the riparian floodplain, with tall shrubs the predominant and preferred browse species (Mould 1979, Carroll 2000). They especially rely on riparian willows for forage, and primarily on the tallest willows, which fall under the tall shrub Earth cover class (USDOI BLM 2002; see "Vegetation," section 3.3.1). As snow cover in the foothills decreases in April, moose begin to disperse into smaller tributaries, uplands, or across the coastal plain, but generally remain in riparian areas.

In Game Management Unit 26A, moose are primarily found during winter in the lower Colville River drainage or either of two major tributaries, the Chandler and Anaktuvuk rivers (Carroll 2005a). These three areas contain the majority of the tall shrub Earth cover class (USDOI BLM 2002) within Game Management Unit 26A, but are outside of the NPR-A. This Earth cover class makes up less than one-tenth of one percent (3,100 acres;

0.01 percent) of the total acreage within the NPR-A (Table 3-16). The low shrub class may also be used by wintering moose, but it covers less than 4 percent of the NPR-A. Of the 998 moose counted during the 2005 census, only 26 (2.5 percent) were seen in the NPR-A (Carroll 2005a). That percentage was 4.7 percent in 1991, before the decline, and 1.5 percent in 1995 near the bottom of the decline. The data for each river drainage in the southern NPR-A, from the Kokolik River on the west to the Etivluk River on the east, suggest the population recovery during the late 1990s and early 2000s expanded from east to west from the core habitat along the lower Colville River.

The observed number of moose in the NPR-A compared to further east in the census area suggests moose winter habitat along rivers within the NPR-A can support less moose than the rivers further east. This hypothesis is supported by the distribution of the tall shrub Earth cover category within and nearby the NPR-A (USDOI BLM 2002; Table 3-16). Despite being unaffected by human activity, moose winter habitat is likely to limit the moose population in the NPR-A. Barring a significant increase in shrubs, the NPR-A may never support high numbers of moose, given historical population trends. However, the increase in shrub cover observed over the last 50 years as air temperatures have warmed (Sturm et al. 2005) suggests the acreage of moose winter habitat in the NPR-A may increase over the next several decades if climate warming continues as predicted.

3.3.6.4 Dall Sheep (*Ovis dalli*)

The Alaska Department of Fish and Game considers the Dall sheep of northwestern Alaska to be divided into three, fairly discrete populations (Westing 2008). Two of these three populations overlap with the southern fringe of the NPR-A in the Brooks Range Physiographic Province (see Map 3.2.4-1). The western portion of this overlap, from Howard Pass west, involves what Westing (2008) refers to as the De Long Mountains population and the eastern portion, from Howard Pass east, the Schwatka Mountains population (Hollis 2008). The third population occurs in the Baird Mountains south of the De Long Mountains and well south of the NPR-A.

Dall sheep habitat generally includes a combination of open alpine ridges, meadows, and steep slopes with rugged "escape terrain" nearby (Hull 1994). Despite relatively continuous, mountainous terrain, sheep are found only in pockets through the western Brooks Range and at low densities in both populations present within the NPR-A. Sheep in this area are at the northwestern margin of their range in Alaska and may be more prone to population changes due to adverse weather than in other parts of the state (Westing 2008). The current condition of Dall sheep habitat in the NPR-A has not been quantified, but due to its remote nature, inaccessibility, and limited past activities, that habitat is expected to have been relatively unaffected by anthropogenic changes or disturbance. The majority of the sheep habitat in this part of the Brooks Range is located on the south side of the continental divide on lands administered by the National Park Service (NPS). As the NPS has greater ability to regulate public and commercial uses than the BLM has in the NPR-A and has a mandate to conserve natural conditions, the habitat there is also expected to be in a mostly natural condition.

High natural mortality greatly reduced both the De Long Mountains (Westing 2008) and the Schwatka Mountains (Lenart 2005) sheep populations in the early 1990s. Prior to 2011, the De Long Mountains population had not been surveyed since 1999, and those earlier surveys were trend counts (i.e., samples of the population, not censuses). The 1999 survey resulted in a density of 0.23 adult sheep per square mile (Dau 2002). Several years later, it was believed that the population was approaching pre-1990s levels (Dau 2005a, Westing 2008), which were estimated at 0.72 adult sheep per square mile in 1983 and 0.65 in 1991 (Dau 2002). In 2011, a distance sampling technique was used to estimate population size, resulting in an estimate of 1,930 sheep (0.67 sheep per square mile) in the De Long Mountains population (Schmidt and Rattenbury 2012). The limited sheep habitat in the NPR-A portion of this population's range suggests that sheep numbers in the NPR-A west of Howard Pass are low and most of those present are found west of the Nuka River headwaters, but some level of sheep use of the NPR-A seems to occur in all years (Dau 2006b). The 2011 survey, which sampled 17 percent of the area, found only one small group of sheep on the NPR-A/NPS border with all the remaining observed sheep occurring on National Park lands south of the NPR-A.

Surveys of sheep in the Schwatka Mountains population have occurred within the Gates of the Arctic National Park, but not within the NPR-A until 2009 and 2010. There is little potential sheep habitat within this part of the NPR-A, involving roughly 100 square miles in four pockets of mountainous terrain separated by broad valleys. This area is on the very margin of the Schwatka Mountains population, where sheep surveys over the past 30 years have resulted in observed sheep densities from 0.3 to 2.8 total sheep per square mile (Lenart 2005, Schmidt and Rattenbury 2010, Schmidt et al. 2012). Some indicators suggest that the Schwatka Mountains population is now stable, but at lower density than observed in the 1980s (Hollis 2008). As is the case with the De Long Mountains sheep population in the NPR-A, there is no valid method for quantifying the number of sheep from the Schwatka Mountains population in the NPR-A. Sheep may occur there at low density, and less regularly than further west with the De Long Mountains population in the NPR-A. None of the sheep observations during the 2009-2010 Schwatka Mountains survey occurred in the extremely limited portion of the survey area on the NPR-A side of the border.

Dall sheep in the eastern Brooks Range have two seasonal home ranges within a year (Summerfield 1974). Both ewes and rams have winter and summer home ranges, and rams also visit ewe winter ranges during rut. Winter home ranges tend to be in areas with relatively little to no snow. The movement from there to summer home ranges varies for individual sheep or bands from almost no movement to up to 25 miles. In the central Brooks Range, a study of seasonal distributions did not indicate any large-scale movements to distinct ranges at different seasons (Lawler 2004) as for the eastern Brooks Range (above) and the western Brooks Range (below). Certain areas appeared to serve as year-round sheep habitat. Annual home ranges were the same for males and females, and averaged about 28 square miles. In the western Brooks Range, sheep are known to make seasonal movements of 30 to 50 miles from summer home range in the higher, central regions of the Baird Mountains to winter home range on lower hills to the north along the Nakolik and Noatak rivers. Seasonal movements of sheep in the NPR-A or elsewhere in the De Long Mountains have not been studied. It is suspected that sheep move back and forth across the continental divide between the NPR-A and the Noatak National Preserve. An aerial survey of sheep along the divide between the Kugururok River on the south and the Utukok River on the north confirmed summer presence in the NPR-A in habitats seemingly unsuitable for winter survival (Shults 2006).

3.3.6.5 Grizzly Bear (*Ursus arctos*)

Grizzly bear densities on the western North Slope are generally highest in the foothills of the Brooks Range and lowest in the northern portion of the NPR-A. The NPR-A's Arctic Coastal Plain is the northern limit of the grizzly bear's range in Alaska, and is considered marginal habitat because of the severe climate, short growing season, and limited food resources (Shideler and Hechtel 2000). Relatively low densities of grizzly bears (0.1 to 0.5 bears per 100 square miles [0.5 to 2 bears per 1,000 square kilometers]) were estimated to use the coastal plain, with the highest densities reportedly east of the NPR-A in the Prudhoe Bay and Kuparuk oil field region (Reynolds 1979, Young and McCabe 1997, Carroll 1998a, Shideler and Hechtel 2000).

In the late 1990s, the number of grizzly bears using the Prudhoe Bay and Kuparuk oil fields east of the NPR-A was believed to be higher than in other coastal plain areas due to the availability of artificial food sources, but those numbers may or may not have been inflated. Productivity of females feeding on anthropogenic foods was high, but post-weaning mortality was also high at 91 percent (Shideler and Hechtel 2000, Lenart 2007a). Following management removal of most of the food-conditioned bears in 2001–2002, the population in the oilfield is thought to have stabilized (Shideler, R.T., 2010, personal communication). These bears have very large home ranges (mean of 1,060 square miles [2,745 square kilometers] for females and 2,146 square miles [5,557 square kilometers] for males; Shideler, R.T., 2010, personal communication) and may travel as many as 50 kilometers per day (Shideler and Hechtel 1995).

An intensive study of brown bear ecology in the southwestern portion of the NPR-A began in 1977 (Reynolds 1979 1992). The 2,000-square mile study area was bounded roughly by the NPR-A boundary on the west and south, the limits of the Utukok Watershed on the east and the Arctic Coastal Plain/Arctic Foothills (Map 3.2.4-1) provinces boundary on the north. Although the individual home ranges of some studied bears extended beyond the NPR-A boundaries to the west and south, the study occurred primarily within the NPR-A. A direct count in conjunction with an intensive individual marking program was used to estimate a total population of 119 bears in the study area, for a density of roughly 6 bears per 100 square miles (23/1,000 square kilometers). These results and others from further east in the Brooks Range were extrapolated to estimate densities for the remainder of the NPR-A (Reynolds 1979). The results were 0.3 bears per 100 square miles on the NPR-A coastal plain (sea level to 1,000 feet elevation; includes Arctic Coastal Plain and Northern Tier of Arctic Foothills provinces), 3 bears per 100 square miles in the NPR-A low foothills (1,000 to 2,000 feet elevation; includes Middle Tier of Arctic Foothills provinces), 2 bears per 100 square miles in the NPR-A High Foothills (2000 to 3000 feet elevation; includes Southern Tier of Arctic Foothills provinces), and 1 bear per 100 square miles in the NPR-A mountains (above 3,000 feet elevation; roughly equivalent to Brooks Range Province). These studies resulted in an estimated total of 900 to 1,120 bears in all of Game Management Unit 26A (all of the NPR-A, lands west to the Chukchi Sea, and lands east to the Itkillik River [Reynolds 1989]). Of this number, Alaska Department of Fish and Game estimated that 400 bears were in the western part of Game Management Unit 26A and 500 to 720 bears were in the eastern part of the subunit (Carroll 2007b).

A 1992 capture-mark-recapture study using radio-collared bears as the "marked" animals was done in the same southwestern study area of the Utukok and Kokolik watersheds. It resulted in a density of almost 8 bears per 100 square miles (30/1,000 square kilometers;

[Machida 1994, Miller et al. 1997]). Combining all of these estimates for the NPR-A confirms that brown bear densities are higher in the southern NPR-A than in the remainder of the NPR-A, and that densities in the Utukok River Watershed are higher than even the rest of the southern NPR-A. In fact, they are higher than anywhere else brown bears have been studied in the northern part of Alaska (Miller et al. 1997). The overlap of this area with the calving ground of the Western Arctic Herd (see page 287), currently the largest caribou herd in Alaska, contributes to the relatively high productivity of this bear population (Reynolds and Garner 1987).

No estimates of brown bear density based on field surveys in the NPR-A have been made since the 1992 work. Based in part on harvest returns, Carroll (2005b) suggests the bear population in Game Management Unit 26A is stable or slowly increasing, and bear densities are high relative to habitat carrying capacity. At the same time, though, Western Arctic Herd numbers are near an all-time high as well. Regardless of the carrying capacity issue, it is obvious that the southern NPR-A is an important habitat for brown bears. It is possible that this area is a source for brown bear dispersal to other areas, and so may have importance to brown bear populations further north and outside the NPR-A as well.

In 1998, bear densities were estimated for broad habitat zones in Game Management Unit 26A using subjective comparisons to areas of the North Slope with known bear densities (Map 3.3.6-13). Densities were estimated at 0.1 to 0.5 bears per 100 square miles on the coastal plain (0.5 to 2/1,000 square kilometers), 3 to 8 bears/100 square miles in the foothills (10 to 30/1,000 square kilometers), and 3 to 5 bears/100 square miles (10 to 20/1,000 square kilometers) in the mountains (Carroll 1998a). Alaska Department of Fish and Game is currently using these same density estimates (Carroll 2007b).

On the Arctic Coastal Plain, grizzly dens occur in pingos, banks of rivers and lakes, sand dunes, and steep gullies in uplands (Harding 1976, Shideler and Hechtel 2000). Although not all criteria for den site selection are known, it appears brown bears select sites that accumulate large snowdrifts for insulation. For at least part of the year, brown bears in the upper Colville River Watershed use east-west oriented ridges north of the river more heavily than the surrounding area. According to Carroll (1998a), these areas should be considered important habitat and be given special protection. Foraging bears have been observed to use the sedge/grass meadows on the bluffs along the lower Colville River during the spring (Swem 1997). In northeastern NPR-A, areas along rivers are important for foraging on vegetation as well as ground squirrels. During early summer, some bears move to coastal wetlands to forage on waterfowl eggs and nestlings (Shideler, R.T., 2010, personal communication).

Grizzly bears are opportunistic omnivores whose food sources vary by region, season, and year. In addition to vegetation and small mammals, bears prey on ungulates and scavenge their carcasses. When caribou are calving, some bears may specifically select for caribou calves. For these bears, caribou calves are an important early season food. In northeastern NPR-A, much of the landscape is underlain by Pleistocene sand dunes, providing good habitat for arctic ground squirrels, which in turn are a major food item for brown bears there.

Brown bears within the NPR-A do not demonstrate seasonal movements similar to a migration, but rather have a home range within which they den for the winter and move back and forth during the remainder of the year (Reynolds 1979). In southwestern NPR-A, the mean home range size of breeding males was 197 square miles, whereas the mean for females was 89 square miles. The maximum distance across a single home range varied among bears from 9 to 60 miles.

3.3.6.6 Furbearers

The term furbearer is used here to describe those species of terrestrial mammals that are routinely sought by trappers who place commercial value on the pelts. Furbearers commonly found in the NPR-A include wolf, wolverine, arctic fox, and red fox (Carroll 2004a, 2007c). Of the latter two, arctic fox are more closely associated with the Arctic coastal whereas red fox populations are highest in the mountains and foothills and lowest on the coastal plain (MacDonald and Cook 2009). Boreal forest species such as marten and coyote are rare on Alaska's mostly treeless North Slope, but may occasionally be seen near the mountains along the southern planning area boundary (Carroll 2004a, 2007c). Lynx established themselves on the North Slope after snowshoe hares immigrated to and became plentiful in the Colville River drainage during the 1990s and have been seen as far north as Barrow. The number of lynx sealed was six in 2005–06, none in 2006–07, four in 2007–08, and six in 2008–09 (Carroll in press). These three species are not further discussed here.

Most furbearer harvest in the NPR-A is by local residents engaged in subsistence or other activities. Definitive species population and distribution information is not available, and consequently, Alaska Department of Fish and Game wildlife biologists rely upon annual trapper harvest reports and opinions, information from local residents, and field observations by Alaska Department of Fish and Game personnel to gauge furbearer status and trend information. Due to a lack of sealing agents in most North Slope villages, furbearer harvest information gathered by Alaska Department of Fish and Game is not very accurate (Carroll 2004a, 2007c).

Since the furbearer species covered here occupy a wide variety of habitats, it is difficult to generalize on habitat condition. However, the NPR-A presently remains in a natural state, permitted activities are minimal, and no specific threats to the quality of the habitat are currently known to exist.

Alaska Department of Fish and Game's management goal for furbearers in Game Management Unit 26A, while recognizing that populations fluctuate in response to environmental factors, are simply to maintain populations capable of sustained yield harvests (Carroll 2006b, 2007c).

Wolf (Canis lupus)

Wolf numbers on the Arctic Coastal Plain and Brooks Range have fluctuated since the 1900s in response to changes in prey populations (caribou and moose), a federal wolf control program in the 1950s, and aerial and snowmachine hunting by the public since the 1960s (Carroll 2006b). After bans on aerial wolf hunting in 1970 and land-and-shoot hunts in 1982, the wolf population increased, especially in the mountains and foothills of the Brooks Range (Stephenson 1979).

Although the wolf population of Game Management Unit 26A has not been determined since 1982, more recent sample surveys (1993) estimate the population at 240 to 390 wolves in 32 to 53 packs (Carroll 2006b). The highest wolf densities in the NPR-A are along the Colville River and its tributaries where winter moose densities are also highest. Surveys in an approximately 18,000 square kilometer area near Umiat that includes the Killik River drainage to the west, the Anaktuvuk River drainage to the east, the Colville River drainage between the mouths of the Killik and Anaktuvuk Rivers to the north, and latitude 68°17' to the south showed that the density of wolves increased from 0.7–0.8 wolves per 100 square miles (2.7–3.2/1,000 square kilometers) in 1987 to 1.0–1.6 wolves per 100 square miles (4.0–6.2/1,000 kilometers) in 1992 (Bente 1998, Carroll 2006b), declined to 0.3–0.6 wolves per 100 square miles (1.0– 2.2/1,000 square kilometers) by 1998 (Bente 1998, Carroll 2006b) and increased again to 0.9–1.1 wolves per 100 square miles (3.3–4.4/1,000 kilometers) in 2008. The numbers of wolves seen during spring moose counts were recorded as 0.7 wolves/hour in 1991, 0.5 wolves/hour in 1995, zero wolves/hour in 1999, 0.1 wolves/hour in 2002, 0.4 wolves/hour in 2005, and 1.8 wolves/hour in 2008. The recent increase in wolves is probably due to an increase in the number of caribou wintering in the area in recent years, relatively high numbers of moose, and a substantial arctic hare population (Carroll 2009).

Wolves are likely found throughout the NPR-A, at least on a seasonal basis. Maximum distances across summer ranges of wolf packs ranged from about 28–60 miles (Stephenson 1979). In general, wolves occur wherever adequate numbers of prey species (e.g., moose and/or caribou) are found. Away from the Colville River and its moose concentrations, caribou are the primary food source for wolves in the NPR-A. Wolves are less abundant on the coastal plain because of the seasonal scarcity of caribou, periodic outbreaks of rabies, and hunting pressure (Carroll 2000b). Also, wolves tend to prefer upland and mountain habitats where they can find alternate prey species and better denning habitat. Caribou can be sparse in the southern portion of the NPR-A during winter, perhaps requiring wolves to leave there seasonally to follow the caribou south as far as the lower Noatak River drainage, or less frequently north onto the Arctic Coastal Plain (Stephenson 1979). Wolf distribution and density within the NPR-A are not shown on a map because sufficient data is not available. During summer, small mammals including voles, lemmings, ground squirrels, snowshoe hares, and occasionally birds and fish may supplement their diet (Stephenson 1979, Hull 1994).

The subsistence harvest of wolves is greatest in the southeastern portion of Game Management Unit 26A, where residents of Anaktuvuk Pass and Nuiqsut hunt and trap wolves throughout the winter (Carroll 2006b). The annual subsistence harvest throughout Game Management Unit 26A has ranged from approximately 30 to 120 wolves (Carroll 2006b). The number of wolf pelts sealed by Alaska Department of Fish and Game throughout Game Management Unit 26A decreased in the late 1990s and early 2000s (Carroll 2003), reflecting the wolf decline described above and suggesting it was more widespread than just in the wolf survey area.

Wolverine (Gulo gulo)

Magoun (1985) estimated a fall population of 821 wolverines for the western North Slope (Game Management Unit 26A), based on a density of 0.5 wolverine per 100 square miles. During the three-year period 2000–2003, 60 wolverines were reported harvested in Game Management Unit 26A (Carroll 2004a), and another 54 during 2003–2006 (Carroll 2007c); however, a survey by the North Slope Borough indicated that more animals were harvested and not reported (Fuller and George 1997). Most harvest of wolverines is by residents of the North Slope. These numbers, compared to 13 reported harvested in the two-year period 1991–1993, may indicate increasing wolverine numbers, but could also reflect increased hunter effort and perhaps a higher percentage of harvest reported. Hunters have reported that wolverines in Game Management Unit 26A seem more abundant in recent years, but there have been no recent population surveys (Carroll 2004a). Magoun (1985) estimated that Game Management Unit 26A could sustain an annual harvest of up to 300 wolverines if that harvest included less than 90 females. Because its fur is used in Native parkas, the wolverine is important as a subsistence species (Reardon 1981, Carroll 2007c).

Wolverines are omnivorous (Reardon 1981) and prey upon and scavenge for caribou, relying heavily on caribou carcasses in winter (Magoun 1979). The presence in summer of the large Western Arctic Caribou Herd (see page 287) may explain the greater abundance of wolverines in the southern portion of the NPR-A than in the remainder. They are found in association with caribou calving and post-calving areas. Stomach contents of wolverines harvested in the northern NPR-A have consisted primarily of caribou (USDOI BLM 1978). However, wolverines are also opportunistic foragers and will eat almost anything they can find or kill, feeding year-round on small mammals and birds (Magoun 1979, Hull 1994). Locations of some historical wolverine sightings in the NPR-A are shown on Map 3.3.6-12.

Wolverines use tussock meadows, riparian willow, and alpine tundra as major habitats (USDOI BLM 1978). Wolverine summer home ranges have been measured at 237 square miles for adult males and 71 square miles for adult females (Magoun 1979). After further study to increase sample size, those average home range estimates were adjusted to 241 and 36 square miles, respectively (Magoun 1985). This same study, conducted from 1978–1982 in the upper portions of the Kokolik and Utukok rivers drainages, provided a density estimate of 5.4 wolverines per 100 square miles for the Arctic Foothills and Brooks Range provinces of Game Management Unit 26A (Magoun 1985). Although considered a conservative estimate, it is important to note that this is as high or higher than wolverine densities reported anywhere throughout their northern hemispheric range (Magoun 2005). Although wolverines are known to be resident in the Arctic Coastal Plain province (Magoun 1979), data were not available to estimate densities there. Based on the substantial habitat differences, wolverine density was assumed to be lower on the coastal plain (Magoun 1985) as suggested by Bee and Hall (1956).

Wolverines have a relatively low reproductive rate (Reardon 1981). Reproductive den sites of wolverine in the NPR-A have been characterized as long, complex snow tunnels with no associated trees or boulders (Magoun and Copeland 1998). Since the depth of snow over tunnels measured 1 to 2.4 meters, deep snowdrifts were required for den site selection. Wolverines prefer vast areas of wilderness; preservation of habitat, including a system of refugia, is the key to successful wolverine management (Hull 1994, Magoun and Copeland 1998). As explained above, the southern portion of the NPR-A may contain a wolverine density as high as or higher than anywhere else on earth.

Arctic Fox (Alopex lagopus)

The arctic fox is the most common furbearer on the Arctic Coastal Plain in and near the NPR-A and its numbers have probably increased with the decline of pelt harvesting since 1929 (Chesemore 1967). Individuals are occasionally found inland as far as the Brooks

Range (MacDonald and Cook 2009). No quantitative population information is available for arctic foxes in Game Management Unit 26A (Map 3.3.6-1). Local hunters and trappers harvest arctic foxes, but since there is no sealing requirement, harvest information is not collected. Nevertheless, low fur prices in the last decade or two have resulted in relatively few foxes being trapped (Carroll 2007c). Arctic foxes are particularly vulnerable to rabies and their populations tend to fluctuate with the occurrence of the disease and with changes in food availability.

Arctic foxes in the Prudhoe Bay oil field area readily use development sites for feeding, resting, and denning, and their densities are greater in the oil fields than in surrounding undeveloped areas (Eberhardt et al. 1982, Burgess et al. 1993, Burgess 2000), suggesting that anthropogenic food sources may support a population increase. Pamperin (2008) demonstrated that arctic foxes fitted with satellite collars in the oil fields traveled about 2 kilometers per day during the winter months while animals collared in pristine areas of the NPR-A traveled about 20 kilometers per day during the winter. The availability of winter food sources has a direct impact on fox abundance and productivity (Angerbjorn et al. 1991). Peak fox populations are associated with abundant lemming populations, their primary prey. Voles are also important prey year-round for arctic foxes. Both arctic and red fox (discussed in the following section) can be important predators of ground-nesting birds and their nests (see sections 3.3.5, "Birds," and 3.3.8,"Threatened and Endangered Species," Spectacled and Steller's eiders). Other food sources include ringed seal pups and the carcasses of other marine mammals and caribou, which are important throughout the year (Chesemore 1967, Hammill and Smith 1991). Tundra-nesting birds form a large part of their diet during the summer (Chesemore 1967, Fay and Follmann 1982, Quinlan and Lehnhausen 1982, Raveling 1989).

Red Fox (Vulpes vulpes)

Red fox are found throughout the NPR-A, but especially along riparian drainages in the mountains and foothills (Reardon 1981, MacDonald and Cook 2009). They are described as fairly abundant in the interior regions of Game Management Unit 26A, but no quantitative information on red fox populations is available for any of that unit (Carroll 2007c). Local hunters and trappers harvest red fox; however, there is no sealing requirement for red fox pelts so no harvest information is available from Alaska Department of Fish and Game.

Although red fox occur on the coastal plain, they are less common there than arctic fox. A study of wildlife on the northern Colville Delta found 12 fox dens between 1992 and 2002, 10 of which were of arctic fox and only 2 were red fox dens (Johnson et al. 2003). Local residents have noticed an increase of red fox in recent years coincident with warmer winters. The red fox is dominant wherever the ranges of the two species overlap. In these areas, red foxes have been observed digging Arctic foxes from their dens and killing them (Jennings 1994). Red foxes are omnivorous, eating a variety of items including insects, small mammals, birds, eggs, berries, and carrion (Reardon 1981, Hull 1994).

3.3.6.7 BLM Sensitive Species of Terrestrial Mammals

BLM sensitive species are a subset of the BLM special status species category and are designated by the BLM State Director for Alaska. Of four species of terrestrial mammals that are currently listed as sensitive by BLM-Alaska (Appendix F), only the Alaskan hare

(*Lepus othus*) has been known to occur in the NPR-A (MacDonald and Cook 2009). A summary of what is known of the Alaskan hare in NPR-A can be found in the discussion of "Special Status Species" in section 3.3.8.

3.3.6.8 Terrestrial Mammals and Climate Change

Temperatures in Alaska and throughout the Arctic are thought to have fluctuated considerably over the last few centuries (Mann et al. 1999). Despite this fluctuation, the last 100 years appear to have been the warmest century in the last 400 years (Overpeck et al. 1997, Intergovernmental Panel on Climate Change 2001, Arctic Climate Impact Assessment 2004). Alaska's surface air temperature has warmed throughout much of the state since at least the mid-1970s (Intergovernmental Panel on Climate Change 2001, Arctic Climate Impact Assessment 2004). Continued warming of the climate could have major effects on the ecosystems of Alaska, particularly the North Slope. However, the large amount of natural variation inherent in the climate system and the complexity of tundra ecosystems make predicting the effects of climate change on terrestrial mammals difficult.

The climate change scenario presented here (Scenarios Network for Alaska Planning 2011) for the rest of this century suggests that climate will get warmer and involve greater precipitation. Summer temperatures may increase about 3 °F over the NPR-A as a whole in the next 30 to 40 years, and about 6 °F in the next 80 to 90 years. Winter temperatures are expected to increase much more, about 11 °F and 18 °F by the 2040s and the 2090s, respectively. Summer precipitation may increase by about 1 inch by the 2040s and another one-half inch by the 2090s. These may not sound like significant increases, but represent 19 percent and 26 percent increases, respectively. Winter precipitation is expected to increase even more at 1.6 inches and 2.7 inches for the two time periods. These are increases of 35 percent and 58 percent, respectively.

Increases in winter precipitation would result in deeper snow pack, and increased winter temperatures may lead to more ice layers within the snow pack. Both (and especially the latter effect) could make winter access to forage more difficult for some mammals (e.g., caribou). Longer summers with increased temperatures would likely result in more days of greater insect activity. The result of these climate changes from the perspective of vegetation is that significant changes in plant communities of the NPR-A may be expected (see section 3.3.1.4, "Vegetation and Climate Change"), especially in the southern foothills and mountains. All of these changes may affect any of the above terrestrial mammal species in a number of different ways.

It has been predicted that an increase in abundance of deciduous shrubs, especially birch (less favorable caribou forage), and a decline in the abundance of grasses-sedges such as tussock cottongrass (an important food of calving caribou), would occur if temperatures in the Arctic were to increase, thereby reducing the amount of available forage for caribou on the North Slope (Anderson and Weller 1996). Other studies have predicted shifts in the composition of Arctic tundra, not only toward increased shrub height and cover extent (Chapin et al. 1995, Sturm et al. 2001, Walker et al. 2006), but also increased grass and sedge species (contrary to Anderson and Weller 1996). Any of these increases would likely be at the expense of lichen (an important caribou winter forage) and moss cover (Chapin et al. 1995, Cornelissen et al. 2001, Jorgenson and Buchholtz 2003, Epstein et al. 2004, Walker et al. 2006). The apparent disagreement regarding sedges may be a question of relative abundance versus net primary productivity. Net primary productivity is predicted to increase in both shrubs (especially birch) and sedges (Euskirchen 2009), but percent canopy cover of birches may increase at the expense of canopy cover of sedges. Indeed, changes like this have already been observed to some extent on the North Slope.

Over decades, warming temperatures could even result in the northward expansion of taiga woody plants (taiga forests) into tundra habitat (Starfield and Chapin 1996, Scenarios Network for Alaska Planning 2011), creating a less favorable habitat for tundra mammals and potentially affecting their populations. However, an increase in tall shrubs could benefit wintering moose while predator populations would likely track those of their prey. Warmer temperatures could also result in increased insect abundance and periods of activity (National Research Council 2003), which may reduce caribou productivity. Insect-relief habitat could become increasingly important, due to increased insect abundance and activity (Klein 1999). Coastal erosion and the inundation of low-lying areas along the coast due to increases in sea level may alter the availability and extent of insect-relief areas and may cause shifts in the usage of particular areas. Alternatively, if predicted weather patterns result in increased wind speed or changes to predominant wind direction, insect flight may be suppressed or caribou movements and distribution may be altered. Caribou calving grounds could shift in response to changes in vegetation. Eventually, areas presently unavailable for leasing may become less important to caribou, while areas that are available for leasing could become more important.

Alaska's North Slope experienced its largest historical wildfire (256,000 acres) during the 2007 summer in an area approximately 25 miles east of the NPR-A (see section 3.3.1.4 for more detail). Scenarios Network for Alaska Planning (2011) projects that over the rest of this century, NPR-A will become dryer and by the 2090s, the potential for fire will increase slightly. A study of tundra vegetation recovery following a fire event near the NPR-A western boundary (Racine et al. 1987) found lichens may take several decades to recover while total vascular plant cover returned to pre-fire levels in 6 to 10 years. Indeed, a more recent review that integrates effects of wildfire, climate warming, and caribou grazing suggests a lichen decline in tussock tundra may accelerate and lichen communities may potentially disappear (Joly and Jandt 2007). Regardless of whether lichens decline in abundance North Slope-wide or completely disappear, the effect on wintering caribou may be negative since lichen is important caribou winter forage. Increases in caribou winter mortality or decreases in calf productivity as a result of increased wildfire may be additive to other impacts discussed in Chapter 4.

In addition to changes in vegetation and caribou or moose habitat, climate warming may cause an increase in insect activity, both in intensity and seasonal duration, which could ultimately result in decreased caribou calf productivity. Changes in habitat and higher energy expenditures for insect avoidance could interact to decrease caribou productivity. If the effect is great enough and continues for a long enough period of time, caribou or other mammals could suffer negative population level effects.

The Arctic Climate Impact Assessment (2004) noted that the Porcupine Caribou Herd, which is the largest migratory herd of mammals shared between the U.S. and Canada, has declined about 3.5 percent annually since 1989, possibly due to climatic effects. However, during this same period, the Western Arctic Herd, Central Arctic Herd, and Teshekpuk Caribou Herd populations have increased. A warming trend would stimulate faster plant growth in the spring, which could result in higher calf growth rate and allow cows to replenish fat reserves sooner. Alternatively, increased growing-degree days in the spring could result in earlier green-up and the current synchronous nature of caribou calving and peak green-up may be disrupted.

The only certainty with climate change is the uncertainty regarding what will actually occur and to what degree it will occur. Predictions generally suggest that future conditions on the North Slope will be less favorable to Arctic-adapted species, such as muskoxen, caribou and arctic fox, and perhaps more favorable to boreal-adapted species such as moose and red fox. The effects of climate change on mammal populations could in many cases be additive to those effects of oil and gas exploration and development in many cases, and any positive or negative changes may impact terrestrial mammal species.

3.3.7 Marine Mammals

Many important marine mammal species can be found within the waters adjacent to the NPR-A, including pinnipeds (seals and walrus), cetaceans—both odontocetes (toothed whales) and mysticetes (baleen whales), and polar bears. All of these species are protected under the Marine Mammal Protection Act of 1972, which places a moratorium on the taking (to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal) or importation of marine mammals and marine mammal products. Exceptions are provided for in the Act, which include but are not limited to actions such as the harvesting of marine mammals by Alaska Natives and the taking of marine mammals with the issuance of a permit. Many marine mammals are also listed or proposed for listing under the Endangered Species Act (ESA). Marine mammals that may be present in or adjacent to the planning area are listed in Table 3-20. The table lists the status of the species under the Marine Mammal Protection Act and the ESA, the scientific and Iñupiaq names for the species, current population size estimates, and the seasonality of the species in or adjacent to the NPR-A. Species with status under the ESA or through BLM policy can be found in section 3.3.8. Listing under the ESA does not preempt regulation under the Marine Mammal Protection Act, but instead adds an additional layer of protection and regulation. Marine mammals are important to the cultural and nutritional health of Alaska Natives within the planning area. Specific information on species importance to Alaska Natives can be found within species sections.

3.3.7.1 Ice Seals (Pinnipeds)

Spotted Seal

The spotted seal (*Phoca largha pallas*) inhabits the North Pacific (Quakenbush 1988), with birthing, pupping, weaning, mating, and molting tending to occur in the Bering Sea from March to June (Burns 1978, Frost et al. 1983, Lowry et al. 1998, 2000, Boveng et al. 2009). Only one stock (Bering Sea) is presumed to occur in Alaska although there are other stocks in eastern Asia. The National Oceanic and Atmospheric Administration performed a status review on the Bering Sea stock in 2009 and determined that it was not warranted for listing consideration under the ESA (U.S. Department of Commerce, National Oceanic and Atmospheric Administration 2009a).

Table 3-20. Marine mammal species of the Beaufort and Chukchi seas including common, scientific, and Iñupiaq name, abundance and residency classification, and status under the Marine Mammal Protection Act and Endangered Species Act

Common name	Scientific name	Iñupiaq name	Abundance	Seasonal residency	Status under MMPA[8]	Status under ESA[8]
Bearded seal	*Erignathus barbatus*	Ugruk	Reliable estimate unavailable[1]	Year-round	Protected	Proposed threatened[11]
Beluga whale	*Delphinapterus leucas*	Sisuaq/ kilalugak	39,258 BS[2](1992) 3,710 CS[3] (1991)	Seasonal	Protected	Not listed
Bowhead whale	*Balaena mysticetus*	Agviq	12,631, 95% CI (7,900–19,700)[4]	Seasonal	Depleted	Endangered
Fin whale	*Balaenoptera physalus*		Reliable estimate unavailable[1]	Extralimital & seasonal	Protected	Endangered
Gray whale	*Eshrichtius robustus*	Agviqluaq	20,110±1,766[5]	Seasonal	Protected	Not listed
Harbor porpoise	*Phocoena phocoena*	Agviqsuaq	48,215[1] (Bering Sea)	Seasonal	Protected	Not listed
Humpback whale	*Megaptera novaeangliae*		Reliable estimate unavailable[6]	Extralimital & seasonal	Depleted	Endangered
Killer whale	*Orcinus orca*		Reliable estimate unavailable	Extralimital & seasonal	Protected	Not listed
Minke whale	*Balaenoptera acutorostrata*		Reliable estimate unavailable	Seasonal	Protected	Not listed
Narwhal	*Monodon monoceros*		Reliable estimate unavailable	Extralimital & seasonal	Protected	Not listed
Polar bear	*Ursus maritimus*	Nanuq	1,526 (95% CI=1,211-1,841) (2006) SBS[7] 2,000+(2010) CS[9]	Year-round	Protected	Threatened
Ribbon seal	*Histriphoca fasciata*	Qaigullik	Reliable estimate unavailable[1]	Reliable estimate unavailable	Protected	Not listed
Ringed seal	*Phoca hispida*	Qaibulik/ qaubutlik	Reliable estimate unavailable[1] (partial surveys indicate >200,000 in 2000)	Year-round	Protected	Proposed threatened[12]
Spotted seal	*Phoca largha*	Qasigiaq	Reliable estimate unavailable[1]	Seasonal	Protected	Not listed[10]
Pacific walrus	*Odobenus rosmarus divergens*	Aviq	129,000 (95% CI = 55,000–507,000)[10]	Seasonal	Protected	Candidate[13]

1. Allen and Angliss (2011).
2. Beaufort Sea Stock; Duval (1993); Harwood et al. (1996); minimal population estimate. Numbers in parentheses are date given for last population estimate.
3. Chukchi Sea Stock; Frost et al. (1993); Allen and Angliss (2010); minimal population estimate.
4. Koski et al. (2010); 5. Rugh et al. (2008);
6. Reliable estimate not available for the Bering, Chukchi, and Beaufort seas. In the central and eastern north Pacific, the estimate of humpback whale population is 19,594 (Calambokidis 2008).
7. Southern Beaufort Sea population from Regehr et al. (2006).
8. The Marine Mammal Protection Act automatically classifies endangered species as depleted; all depleted stocks are strategic stocks. Species with status under the ESA are addressed in section 3.3.8.
9. Chukchi Sea from U.S. Department of Interior, Fish and Wildlife Service (2010)
10. Speckman et al. (2010).
11. U.S. Department of Commerce, National Oceanic and Atmospheric Administration (2010a).
12. U.S. Department of Commerce, National Oceanic and Atmospheric Administration (2010b).
13. U.S. Department of Interior, Fish and Wildlife Service (2011b).

The importance of sea ice for this species has been widely recognized, especially for reproduction (McLaren 1990). This seal's seasonal distribution, however, is more complicated than the presence or absence of sea ice. Quakenbush (1988) noted that when sea ice was absent this seal's habitat requirements coincide with the harbor seal. In winter and early spring, spotted seals are associated with the front zone of pack ice. As sea ice melts, there is a general movement north and off-coast following ice margins (Frost et al. 1983), but typically restricted to waters less than 200 meters deep (Braham et al. 1984). Also, in summer, when ice floes are less frequent, smaller in size (less than 10 meters diameter) (Burns 1970, Burns et al. 1981, Quakenbush 1988), and/or where ice occurs in water depth greater than 200 meters (Braham et al. 1984), spotted seals are associated with coastal habitats and land-based haul-outs (Frost et al. 1983 [see Figure 4 that estimates haul-outs at 500 or greater individuals]; McLaren 1990) until the return of favorable ice conditions.

Summer concentrations of this species are generally smaller in the Beaufort Sea and usually do not extend east of the Colville River delta in Alaska. The spotted seal has, therefore, been described as a "seasonal visitor" to the Beaufort Sea (Burns 1978; see also composite distribution map in McLaren [1990]). In contrast, spotted seal numbers in the Chukchi Sea appear much greater, with several major haul-outs along the Chukchi Coast (McLaren 1990), including Kasegaluk Lagoon (especially the Utukok and Akoliakatat passes), the mouth of the Kuk River (Wainwright), and the mouth of the Kugrua River (Peard Bay area) (Frost et al. 1993). Counts in excess of 1000 spotted seals hauled out in Kasegaluk Lagoon are not uncommon from late-July through late-September (Frost et al. 1993). Haul-outs tend to be isolated, disturbance-free locations associated with fish spawning areas (Frost et al. 1982, Quakenbush 1988, Boveng et al. 2009).Spotted seals have also been observed 30 kilometers up the Kukpuk River (near Point Hope) feeding on salmon and smelt (Frost et al. 1982, 1983).

A reliable estimate of population size is unavailable (Rugh et al. 1995; Allen and Angliss 2011). Previous estimates of the worldwide population suggested there may be 335,000 to 450,000 animals (Burns 1973). In 1993, aerial surveys were flown over known haul-outs (Rugh et al. 1995). Correcting counts of animals at haul-outs for seals at sea provided an estimate of 59,214 (Allen and Angliss 2010); however, based on recent but incomplete surveys, Boveng et al. (2009) estimated that there are more than 100,000 spotted seals in the Bering Sea breeding population.

The spotted seal has been known as subsistence species for many generations. Non-native recognition of the subsistence importance of this seal was noted as early as 1855 by Dr. John Simpson, surgeon on the HMS Plover, during the first non-Native overwintering trip to Point Barrow in search for Sir John Franklin (Simpson 1855 [see footnote 2]). Predominately, subsistence hunting occurs in the Bering Strait and Yukon-Kuskokwim region (Lowry 1984, Quakenbush 1988). On the North Slope of Alaska, this species is also hunted, but is not pursued as greatly as the more abundant ring seal (Bacon et al. 2009). An annual take of 5,265 spotted seals has been estimated for Alaska (not only NPR-A areas) (Angliss and Allen 2009 [cited in Boveng et al. 2009]). The Soviet Union had at times (1930s, 1960 to 1983) engaged in commercial sealing (see Quakenbush [1988] for a list of references related to Soviet commercial hunting), which may have qualitatively impacted regional populations. Though commercial hunting of this species in the Russian Far East continues (Boveng et al. 2009), the worldwide population appears relatively stable, with sources of mortality not expected to increase (Burns 1978, Quakenbush 1988). Neither current, accurate abundance estimates or quantitative population trend estimates have been published for this species. Quakenbush (1988) cautioned that,under such conditions, major population fluctuations could occur without detection. Robilliard et al. (1989), citing a general body of research by Geraci and St. Aubin (see McLaren [1990] for the list of relevant papers), states that pinnipeds are not considered particularly sensitive to spilled oil; however, an earlier Outer Continental Shelf Environmental Assessment Program report (Frost et al. 1983) as well as Quakenbush (1988) note that spotted seals in Kasegaluk Lagoon could “likely to be impacted by OCS [Outer Continental Shelf] activities” and highlighted this species and location for further study.

Ribbon Seal

The ribbon seal (*Histriophoca fasciata*) inhabits the North Pacific (Kelly 1988 [see also composite distribution maps in McLaren (1990) and in Boveng et al. (2008)]). For the most current synthesis on the ribbon seal, see Boveng et al. (2008). It is an open water species inhabiting primarily offshore water during its nonbreeding season, very rarely hauls out on land (McLaren 1990, Kelly 1988, 2009, Boveng et al. 2008), and during the breeding and molting seasons associates with relatively thick, clean ice floes inside the dynamic pack ice margin (Burns 1981, Kelly 1988). Only one stock is assumed to be in Alaska (Allen and Angliss 2010).

In Alaska, the ribbon seal is most abundant in the Bering Sea and in Bristol Bay, where pupping, breeding, and molting take place on pack ice and on floes or ice remnants greater than 20 meters (Kelly 1988, Boveng et al. 2008); however, the extent of range can encompass the Chukchi Sea and large areas of the western Beaufort Sea (Burns et al. 1981, Braham et al. 1984, Boveng et al. 2008), especially if proper ice conditions during molt are not found in the Bering Sea (Boveng et al. 2008). While this species typically is outside of the NPR-A related areas, it was a subsistence-hunted animal before Western contact in the 1700s (Kelly 1988), noted specifically during contact (Simpson 1855 [see footnote 2]), and has been sighted near the ice edge off Barrow in August

A comprehensive population estimate has not been conducted. Various reports from the mid-1970s (Kelly 1988) to Boveng et al. (2008) suggest that the population “likely compris[es] at least 200,000 individuals.” While it appears that the greatest threat to populations is habitat loss due to diminishing sea ice, Boveng et al. (2008) suggests reproduction will most likely not be affected greatly since it occurs in northern Bering Sea and Sea of Okhotsk from March-early May where projections forecast continued “substantial ice.” Other impacts to the ribbon seal could be increased shipping in the Chukchi Sea, but, again, Boveng et al. (2008) states there is little relevant information addressing this issue. They do note that since this seal is typically associated with pack ice and larger ice remnants, ships most likely to encounter the seal would be larger ice-worthy craft.

In 2008, the National Oceanic and Atmospheric Administration performed a 12-month status review of the ribbon seal and determined it was not warranted for listing under the ESA. However, in response to new information and ongoing litigation regarding the ribbon the seal, the agency initiated a new status review in December 2011 (76 *Federal Register*

77467 [December 13, 2011]). The findings of the new review are expected to be announced in December 2012.

3.3.7.2 Baleen Whales (Mysticetes)

Gray Whale

The Eastern North Pacific Stock of gray whales (*Eschrictius robustus*) migrates annually between breeding lagoons in Mexico and high-latitude feeding areas. The majority of this stock spends the summer feeding in the northern and western Bering and Chukchi seas. However, gray whales have been reported feeding in the summer in waters from Kodiak Island south to Washington State and are highly mobile within their range (Allen and Angliss 2011). A small remnant population of about 120 animals remains in the western North Pacific, but is not believed to summer in the Bering or Chukchi seas (International Whaling Commission 2011).

Gray whales of the Eastern North Pacific Stock regularly occur in the northeastern Chukchi Sea and near Barrow (Moore and DeMaster 1997). It is unknown how many occur in the Beaufort Sea (Laake et al. 2009); however in autumn, whale hunters at Barrow report high encounter rates with gray whales in the extreme western waters of the Beaufort Sea. Also, gray whales are regularly seen east northeast of Point Barrow during the BOWFEST study (Bureau of Ocean Energy Management- National Oceanic and Atmospheric Administration-North Slope Borough Bowhead Whale Feeding Study) and were nearly as abundant as bowheads in 2009 (Goetz et al. 2009). Most gray whales observed in summer from 1982 to 1991 were in the northern Bering Sea (Moore et al. 2000). In the Chukchi and Beaufort seas, gray whales have been heard off Point Barrow from October through May (Moore et al. 2000) and detected in aerial surveys primarily in nearshore waters from Point Barrow to Icy Cape, and occasionally to the northeast of Point Barrow. In September and October, they have also been observed northwest of Wainwright near the Hanna Shoal as well as off Point Hope to the south (Moore et al. 2000). Subsistence hunters have reported seeing more gray whales near Barrow in late summer and autumn, possibly indicating a northward shift in use areas (Moore et al. 2000). Recent hunter observations indicate gray whales remain into October during the fall bowhead whale hunt at Barrow. Furthermore, Moore et al. (2006) reports detections of gray whales overwintering near Barrow but this may have been an isolated event. Gray whales may be expanding their feeding range in arctic Alaska (Moore and Huntington, 2008), perhaps seizing the opportunity afforded by trends in sea-ice reduction (Moore et al. 2006).

Gray whales frequent areas of shallow water (average depth 125 to 130 feet) and low ice cover (average 1 to 7 percent) depending on season (Moore and DeMaster 1997). These areas provide habitat rich in preferred prey. Gray whales are suction-feeders and prey upon a variety of benthic amphipods, decapods, and other invertebrates in the Bering and Chukchi Seas. Ampeliscid amphipods were the predominant prey targeted in Chirikov Basin in the northern Bering Sea (Moore et al. 2003). Gray whales may have been subject to recent episodes of starvation (LeBouf et al. 2000, Moore et al. 2003) and there are reports of gray whales appearing "thin." The estimated minimum population size for the Eastern North Pacific Stock is 19,126 individuals based on recently revised estimates from surveys conducted during the winter of 2006-2007 (Allen and Angliss 2011). The population has been steadily increasing, a trend that is consistent with a population approaching carrying capacity (Allen and Angliss 2011). As a result, this stock is no longer considered threatened or endangered under the Endangered Species Act and was delisted in 1994.

Gray whales are in the low-frequency cetacean functional hearing group, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). They produce broadband signals ranging from 100 Hz to 4 kHz (and up to 12 kHz). The most common sounds on the feeding grounds are knocks, which are broadband pulses from about 100 Hz to 2 kHz and most energy at 327 to 825 Hz (Jones and Swartz 2009, Richardson et al. 1995). Erbe (2002), inferring from vocalizations, suggested gray whale should be sensitive to frequencies between 20 Hz and 4.5 kHz, with best sensitivity around 20 Hz-1.2 kHz.

Minke Whale

Minke whales (*Balaenoptera acutorostrata*) are distributed worldwide within both temperate and polar oceans. Some, but not all, individuals associate with sea ice in Polar Regions. Two stocks are thought to occur within North Pacific waters: the Alaska stock, and the California/Oregon/Washington stock. There is no abundance estimate for the Alaska stock. Provisional estimates of minke whale abundance based on surveys in 1999 and 2000 are 810 and 1,003 whales in the central-eastern and south-eastern Bering Sea, respectively (Angliss and Outlaw 2008, Shell 2010). These estimates have not been corrected for animals that may have been submerged or otherwise missed during the surveys, and only a portion of the range of the Alaskan stock was surveyed. Since minke whales that occur in the Chukchi Sea are part of the Alaska stock, abundance estimates for that region are unavailable. However, anecdotal sightings by hunters suggest that minke whales are uncommon, but regular visitors to the northeast Chukchi Sea (George 1997). Albert (1979) reported a dead stranded minke whale in the vicinity of Barrow during summer 1979. Another beach-cast animal, 7 meters in length (sex not determined), was reported at Barrow in July 1997 (George 1997).

Industry-sponsored surveys suggest that minke whales are uncommon in the Alaskan Chukchi Sea and rare in the Beaufort Sea (Funk et al. 2010, Brueggeman et al. 2009, Blees et al. 2010). Data from the BWASP/BOWFEST/COMIDA/ASAMM aerial surveys sponsored by the Minerals Management Service and Bureau of Ocean Energy Management corroborate these observations. Recent industry surveys reported eight and five minke whale sightings in 2006 and 2007, respectively, during vessel-based surveys in the Chukchi Sea (Reiser et al. 2009). Fourteen sightings of sixteen minke whales were documented during Joint Monitoring Program ship-based surveys in the Chukchi Sea, 2006 through 2008 (Funk et al. 2010), and and one was seen during boat-based surveys for the BOWFEST study in the waters east southeast of Point Barrow (BOWFEST 2009). Although minke whales were not sighted during aerial surveys of the northeastern Chukchi Sea study area in 2008-2010, there were five confirmed sightings of six minkes (plus an additional four sightings of probable minke whales) from July to September 2011 (Clarke et al. 2012). These recent sightings suggest a possible increase in the numbers of minke whales using the northern Chukchi Sea; they remain rare in the Beaufort Sea with only one documented sighting in 2007 (Jankowski et al. 2009).

Minke whales feed on small fishes such as sand lance, salmon, capelin, cod, walleye pollack, and herring; and they also consume euphasiids and copepods. The annual diet of minke whales is most likely associated with location, seasonal abundance, and availability of prey items (Perrin et al. 2009).

Minke whales appear most sensitive to sound between 100 and 200 Hz, with good sensitivity extending from 60 Hz-2 kHz. High-frequency clicks were published in two studies, indicating some sensitivity between 4 and 7.5 kHz up to 20 kHz (Erbe 2002).

3.3.7.3 Toothed Whales (Odontocetes)

Beluga Whale

There are at least five stocks of beluga whales (*Delphinapterus leucas*) in Alaska: Cook Inlet, Bristol Bay, eastern Bering Sea, eastern Chukchi Sea and Beaufort Sea (O'Corry-Crowe et al. 1997, 2002). A sixth stock likely exists in Kotzebue Sound (O'Corry-Crowe et al. 2002). Names of the stocks are based on summer concentration areas. Two stocks occur adjacent to the NPR-A, the eastern Chukchi and Beaufort seas stocks. The putative Kotzebue Sound stock may also occur adjacent to the NPR-A, but little is known about their movements. Both the Chukchi and Beaufort stocks overwinter in the Bering Sea.

Whales from the Beaufort Sea stock overwinter in the western Bering Sea (Richard et al. 2001) and move north in April and May though open leads and polynyas (large openings) in the sea ice, usually within about 40 miles of the Chukchi Sea coast and possibly farther out in the Beaufort Sea. They migrate along the northwest and north coasts of Alaska to summering areas in the Canadian Beaufort Sea, concentrating in the Mackenzie River Delta. Satellite-tagged animals revealed that belugas move throughout much of northwestern Canada during the summer (Richard et al. 2001) with some differences between males and females (Loseto et al. 2006). In autumn, those whales migrate west out of Canada, primarily along the Beaufort Sea shelf break and in deeper water (Moore 2000, Richard et al. 2001) toward the Chukchi Sea and then south returning to wintering areas (Richard et al. 2001).

Chukchi Sea belugas appear to overwinter in the northern Bering Sea between Saint Lawrence Island and Chukotka, Russia, based on the movements of a satellite-tagged whale (Suydam 2009). These animals arrive in the Chukchi and Beaufort seas later in the year than Beaufort belugas. They migrate to the vicinity of Kasegaluk Lagoon, off of western NPR-A in mid- to late June. Little information is available about the migratory route from the Bering Sea to this summering area; however, one satellite tagged animal was tracked from a wintering location in the northern Bering Sea north through the Chukchi Sea to the vicinity of Barrow Canyon before it returned south to the vicinity of Kasegaluk Lagoon (Suydam 2009). During late-autumn, Chukchi Sea belugas migrate west and south through the western Beaufort Sea and the Chukchi Sea, and then south through the eastern portion of the Bering Strait (Suydam et al. 2001).

Chukchi and Beaufort belugas may use areas near NPR-A each summer. This occurs during spring and autumn migrations and during the open water summer. Of particular importance are Omalik Lagoon, the passes (i.e., breaks in the barrier islands) along Kasegaluk Lagoon, Kuk Inlet, and Barrow Canyon (Frost and Lowry 1990, Frost et al. 1993, Suydam et al. 2005, Suydam 2009).

Harwood et al. (1996) estimated the Beaufort Sea stock to be 19,629 animals (CV=0.229). This estimate was derived from an aerial survey conducted in 1992. Duval (1993 [cited in Allen and Angliss 2010]) accounted for availability bias by applying a correction factor of 2, resulting in a population estimate of 39,258 animals (19,629 × 2). This corrected estimate is viewed as low by the National Marine Fisheries Service's Alaska Scientific Review Group (Allen and Angliss 2010) considering that the aerial survey correction factor for this species has been estimated to be between 2.5 and 3.27 (Frost and Lowry 1995). Furthermore, only a portion of the Beaufort Sea beluga range was surveyed in 1992 (Harwood, L., personal communication) suggesting that the population is even larger. The trend of this stock is unknown (Allen and Angliss 2010).

Aerial surveys, primarily along the Chukchi Sea coast, but also including some offshore areas, have been flown regularly since the late 1970s to estimate the population size and trend of the eastern Chukchi Sea stock. Surveys are often hampered by challenging weather and sea ice conditions. Surveys in the 1990s and early 2000s provide minimal estimates because it was clear that only a portion of the range was surveyed and sea ice hampered the ability to obtain a complete count (Frost et al. 1993, DeMaster et al. 1998, Lowry and Frost 2002). The Alaska Scientific Review Group concluded that a population estimate of 3,710 whales was a minimal one (Small and DeMaster 1995, Allen and Angliss 2010) because the distribution of the stock was much greater than the surveyed area (Lowry and Frost 2002, Suydam et al. 2005). The Alaska Scientific Review Group considers the stock to be stable (Allen and Angliss 2010).

Belugas are often very gregarious. They can be found in groups numbering thousands of individuals or can be found as solitary animals or small groups. During summer, large groups visit traditionally used areas that may include rocky beaches or brackish water. It is likely that belugas go to this area annually to molt their skin (St. Aubin et al. 1990), but there may be thermal advantages to newly born calves. Breeding probably takes place in January to March and gestation lasts for approximately 15.5 months (Robeck et al. 2005, Suydam 2009). Thus, belugas give birth in about June and July. Females give birth every 2 to 3 years on average, but older females may have calves less often (Burns and Seaman 1986, Suydam 2009). They can live to at least 60 years based on enumeration of growth layer groups in teeth and an assumption of the deposition of one growth layer group per year (Stewart et al. 2006), but they may live longer (Suydam 2009).

The diet of beluga appears to be quite varied although there is relatively little published on the diet of belugas from the Beaufort and Chukchi seas. Fish and invertebrates both seem to be important. Some stocks rely heavily on large salmon (*Onchorynchus* sp.) runs, such as the Cook Inlet and Bristol Bay stocks (Seaman et al. 1982, Quakenbush, L., unpublished data), while more northerly stocks may rely more on Arctic cod, other fishes, and invertebrates such as cephalopods and shrimp (Seaman et al. 1982, Loseto, L., personal communication).

Beluga whales are an important subsistence resource of the Inupiat in Alaska and the Inuit in Canada. Point Hope, and occasionally Barrow harvests belugas during the spring migration from the ice edge. During the early summer Point Lay and Wainwright have community hunts. Point Lay in particular depends on belugas and harvests about 40 animals per year (Suydam 2009, Frost and Suydam 2010). Kaktovik, Nuiqsut, and Barrow may periodically land belugas during the late summer or autumn (Frost and Suydam 2010).

Belugas possess a diverse vocal repertoire, and are the most vocal of the toothed whales. They emit as many as 50 whistles and pulsed calls (e.g., groans, buzzes, trills, and roars) at frequencies from 0.1-12 kHz. This behavior has earned them the nickname "sea canary" (O'Corry-Crowe 2002). Belugas hear sounds at frequencies as low as 40-125 Hz but, below about 10 kHz, sensitivity diminishes with frequency (Richardson et al. 1995b).

Narwhal

The narwhal (*Monodon monocerus*) is an ice-associated cetacean with discontinuous polar distribution. Narwhals occur year-round above the Arctic Circle and are rarely seen south of 61° N latitude. Narwhal are primarily located in the eastern Canadian Arctic, off Greenland, and in the European Arctic, and are considered rare in the Beaufort and Chukchi seas (Dietz et al. 2001, Reeves et al. 2002). There have been periodic sightings of narwhals or skeletal remains found in the Beaufort, Chukchi, and Bering seas (Bee and Hall 1956). Huey (1952) reported a specimen found near the mouth of the Colville River, Alaska noting the individual submitting the specimen in 1928 wrote that "the Narwhal is so seldom seen in the northern Alaskan waters that the local Eskimos have no name for it." Geist et al. (1960) reported three additional records: a complete skeleton and tusk found at Kiwalik Bay in August 1957; a complete carcass found in April 1957, at the mouth of the Caribou River in Nelson Lagoon); and a section of tusk found on the beach at Wainwright, Alaska. More recently, there appears to be an increase in sightings of narwhals off northern Alaska by subsistence hunters (George and Suydam 2009). There have been two sightings in the Beaufort and five sightings in the Chukchi since 2000. All the animals were identified as males (i.e., they all had tusks) and all sightings occurred in the open water season, primarily in July and August. It may be that females are also seen but not recognized as narwhals. It is unclear whether the sighted narwhals had moved east across the Russian Arctic to Alaska or west from Canadian waters. There is no indication that there is a breeding or resident group of narwhals in the Beaufort or Chukchi seas off Alaska. Narwhals are currently considered to be rare, transient visitors to the Alaskan Arctic.

In Canada and Greenland, narwhals are known to prey upon Arctic cod, polar cod, gonatus squid, and Greenland halibut (Heide-Jørgensen 2009).

Harbor Porpoise

The harbor porpoise (*Phocoena phocoena*) is a small-toothed whale that is known to occur in shallow, coastal waters in the Northern Hemisphere, especially in temperate waters but also in the subarctic (Read 1999). Ice likely precludes these small cetaceans from occurring in seas with persistent ice cover.

The stock structure in Alaska is poorly known because of small sample sizes of genetic material, but the National Marine Fisheries Service recognizes three stocks based on arbitrary boundaries; Southeast Alaska, Gulf of Alaska, and Bering Sea (Allen and Angliss 2011). Those that move into the Chukchi and Beaufort seas during the summer ice-free months are presumably from the Bering Sea stock.

Little is known about the distribution and abundance of harbor porpoises in the Chukchi and Beaufort seas. Until 2006, sightings were provided mostly from subsistence hunters and from by-caught animals in subsistence fishing nets (Suydam and George 1992).

However, recent changes in ice extent and thickness during the summer may be resulting in greater numbers of porpoises in the area.

Harbor porpoises had been considered uncommon, but rare in the Chukchi and Beaufort seas (Bee and Hall 1956). It appears that Barrow is near the limit of the harbor porpoise range; however, there are some sightings in the Beaufort in the Mackenzie River Delta (VanBree et al. 1977 [in Gaskin 1984]) and recent industry surveys in the central Beaufort Sea (Lyons et al. 2009, Savarese et al. 2010). Recent vessel-based surveys in the Chukchi Sea commonly observed harbor porpoises (Haley et al. 2009b) suggesting their abundance is changing. Harbor porpoises were one of the most abundant cetaceans seen on those recent surveys. More harbor porpoise (five sightings of 10 individuals) were also seen during boat surveys off Barrow in 2010 than in any previous year (George et al. 2011). The increased number of harbor porpoise may represent a range extension (Funk et al. 2010).

The Bering Sea stock of harbor porpoises was estimated to contain more than 48,215 animals (CV=0.223) (Allen and Angliss 2011). This estimate is biased low because a large portion of their range was not surveyed, including the northern Bering and Chukchi seas.

Harbor porpoise often feed on bottom-dwelling fishes and small pelagic schooling fishes with high lipid content; herring and anchovy are common prey (Bjørge and Tolley 2002, Leatherwood et al. 1982).

Killer Whale

Killer whales (*Orcinus orca*) occur throughout the world's oceans and seas (Leatherwood and Dahlheim 1978). In Alaska, there are three types of killer whales; resident, which eat primarily fish; transients that eat marine mammals; and offshore, that eat primarily marine mammals (Bigg et al. 1990, Ford et al. 2000). Killer whales in the Chukchi Sea, and possibly the Beaufort Sea, are most likely the transient type; they are rare but regular visitors.

In the Beaufort Sea, there are only a few sightings of killer whales (Lowry et al. 1987, George and Suydam 1998). In the Chukchi Sea, sightings are more common. George and Suydam (1998) compiled sightings made by subsistence hunters. Those sightings are comprised primarily of observations of killer whales attacking other marine mammals (primarily gray whales) near Point Barrow and south along the Chukchi Sea coast. George et al. (1994) also provided information on the number of subsistence harvested bowheads that contained scars caused by killer whales. It is not known whether those whales encountered killer whales in the Chukchi and Beaufort seas or in the Bering Sea, or both. Marine mammal observers onboard industry vessels in the Chukchi Sea recorded one killer whale sighting in 2006 and two sightings in 2007 (Reiser et al. 2009).

The Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock is the one most likely to occur in the Beaufort Sea and Chukchi seas. Allen and Angliss (2011) estimated a minimum 552 individuals in this stock, based on photo-identification of individuals. There are no formal surveys conducted specifically for killer whales in the Chukchi or Beaufort seas and sightings during other surveys are rare. The infrequency of sightings during surveys suggests that the number of killer whales in the Chukchi and Beaufort seas is likely low. The reports that do exist are incidental to other activities and surveys, thus, do not provide an estimate of the actual numbers.

Killer whale hearing is most sensitive at 20 kHz (36 dB), with upper frequency hearing limits of about 120 kHz (Szymanski et al. 1999). A lowest threshold of 30 dB re 1 µPa for the male killer whale occurred at 15 kHz. The frequency of best sensitivity was 20 kHz and the range of best sensitivity (±10 dB from lowest threshold) was 18-42 kHz (Szymanski et al. 1999, as cited in Holt 2008)

3.3.7.4 Marine Mammals and Climate Change

Climate change has the potential to greatly affect Arctic marine mammal species. Effects will vary by species and may include but are not limited to expansion or contraction of ranges, loss of important habitat, intermingling of previously separate populations, and introduction of new competitors and diseases. Due to projected effects, several Arctic marine mammal species have recently been listed, proposed for listing, or determined warranted for listing under the ESA (see section 3.3.8.4) including polar bears, two ice seal species, and Pacific walrus. The greatest environmental change that species are predicted to face is a decrease in sea ice concentration and extent (Wang and Overland 2009, Boveng et al. 2008, Boveng et al. 2009, Cameron et al. 2010, Kelly et al. 2010). It is still unclear exactly how changes in ice concentration will affect each species, particularly cetaceans, but it is clear that an effect will occur.

Increased ocean acidification could lead to ecosystem-wide food web changes that affect marine mammals. Calcified marine organisms, such as bivalves, crustaceans, and other invertebrates with calcium carbonate shells or skeletons, are at risk with increasing acidification (Fabry et al. 2009). High-latitude regions are expected to undergo the greatest changes, yet effects of chronic exposure to increased carbon dioxide and long-term implications of reduced calcification on species or communities are unknown (Fabry et al. 2008). Marine mammals that prey directly on calcifying invertebrates, such as some ice seals and gray whales, could be more directly impacted. It is, however, not known if ampeliscid amphipods that are the primary prey of gray whales will be affected by increasing carbon dioxide levels in bottom waters (Fabry et al. 2009). Experimental studies on effects of ocean acidification on Southern Ocean krill suggest that krill evolved a certain level of resistance to increased carbon dioxide, but they might be increasingly vulnerable at high carbon dioxide levels (Kawaguchi et al. 2011). Arctic species of krill may respond similarly. Marine mammal species that feed at higher trophic levels (e.g., on fish or other marine mammals) are less likely to experience direct effects of ocean acidification on prey, but may eventually be impacted through cascade effects though the food chain.

3.3.8 Special Status Species

Special status species include plants and animals listed under the Endangered Species Act (ESA) and sensitive species as identified by the BLM-Alaska State Director following guidance in BLM Manual 6840. There are no plants or terrestrial mammals federally listed under the ESA in the planning area. There are two eiders four marine mammals federally listed under the ESA in the planning area. There are 21 plants, 5 birds, 2 terrestrial mammals, and 3 marine mammals on the BLM sensitive species list known or suspected in the NPR-A. The BLM's list of sensitive species is provided in Appendix F.

3.3.8.1 Plants

In describing plant taxa, Lipkin and Murray (1997) have defined rare plants as those species occurring in 20 or fewer locations throughout Alaska. Rare plants of Alaska's North Slope have more recently been defined and described (Cortés-Burns et al. 2009). This more recent report describes 14 species of rare vascular plants known to occur within the exterior boundaries of the NPR-A, only 9 of which (grouped by general habitat and described below as in Cortés-Burns et al. 2009) meet the criteria to be on the BLM sensitive species list.

Alpine Whitlow-grass (*Draba micropetala*) has been collected off public lands in the vicinity of Barrow. It has not been found on BLM-managed lands within the NPR-A. It occurs in graminoid herbaceous meadows along stream banks and beach ridges on gravelly soil. Adam's Whitlow-grass (*Draba pauciflora*), a tiny herb occurring in the Moist and Wet Tundra classes, is known from a few coastal sites from Pitt Point to Barrow. It is apparently secure globally, but critically imperiled in Alaska. The arctic poppy (*Papaver gorodkovii*) has been collected off public lands near Barrow. It has not been found on BLM-managed lands within the NPR-A. It is rare globally and either imperiled or rare in Alaska (state rank uncertain), and has been found on well-drained to moist substrates near the Arctic Ocean coast.

Oriental junegrass (*Koeleria asiatica*) has been found at several sites in the NPR-A and further west, where it grows on the Barren Ground class on sandy river banks. Oriental junegrass is also secure globally, but imperiled in Alaska. Alaskan bluegrass (*Poa hartzii* ssp. *alaskana*) grows in the Barren Ground class on sand dunes or sparsely vegetated river bars and has been found at one site near the mouth of Fish Creek as well as a few sites along the Meade River. It is rare or uncommon globally and critically imperiled in Alaska. Drummond's bluebell (*Mertensia drummondii*), is a small, blue flowering herb that has been found on sand dune habitats (Barren Ground class) along the Kogosukruk and Meade rivers. Five other sand dune sites within the northeastern NPR-A have been searched for Drummond's bluebell, but no plants have been found (Lipkin, *personal communication*, 1994). Drummond's Bluebell is imperiled both globally and in Alaska.

Sabine grass (*Pleuropogon sabinei*), an aquatic grass, grows in the Aquatic class and has been found between the pendent grass and sedge zones in lakes and ponds. It is secure globally, but critically imperiled in Alaska. It is known in Alaska from only a few locations north and northeast of Teshekpuk Lake.

Circumpolar cinquefoil (*Potentilla stipularis*) grows in wet to moist silty loams, mud, sand and gravel, on vegetated river floodplains and terraces. It has been found at two sites on the Colville River. It is secure globally but imperiled to critically imperiled in Alaska. Grassleaf sorrel (*Rumex graminifolius*) grows on dry to moist sand and gravel on river banks and sand dunes. It has been collected in the vicinity of Atqasuk (Meade River) and further west along the Kaolak River. Its global rank is in question, but it is critically imperiled in Alaska.

In addition to the 9 species described above, an additional 12 species designated as sensitive by BLM-Alaska have been documented on the North Slope (Cortés-Burns et al. 2009, USDA-Natural Resources Conservation Service 2011). None of these has yet been documented in the NPR-A, but their presence there is possible given their occurrence elsewhere on the North Slope. These species are *Erigeron muirii* (Muir's fleabane), *Montia* *bostockii* (Bostock's miner's-lettuce), *Oxytropis arctica* var. *barnebyana* (Barneby's locoweed, *Papaver walpolei* (Walpole poppy), *Pedicularis hirsuta* (hairy lousewort), *Puccinellia wrightii* (Wright's alkaligrass), *Ranunculus camissonis* (glacier buttercup), *Ranunculus turneri* (Turner's butter-cup), *Rumex krausei* (Cape Krause sorrel), *Smelowskia johnsonii* (Johnson's false candytuft), *Symphyotrichum pygmaeus* (pygmy aster), and *Trisetum sibiricum* ssp. *litorale* (Siberian false-oats).

3.3.8.2 Birds

Spectacled Eider

Distribution

The spectacled eider (*Somateria fischeri*) breeds primarily along coastal areas of western and northern Alaska and eastern Russia, and winters in the Bering Sea (Petersen et al. 2000). In Alaska, spectacled eiders have nested discontinuously from the Nushagak Peninsula north to Barrow, and east nearly to Canada's Yukon Territory (Gabrielson and Lincoln 1959, Dau and Kistchinski 1977, Kessel 1989). At present, there are three primary breeding populations: on Alaska's Arctic Coastal Plain and the Yukon-Kuskokwim Delta, and along the Arctic coast of Russia from the Chaun Delta to the Yana Delta (Dau and Kistchinski 1977, Petersen et al. 2000, Solovieva and Lyatieva 2006). Spectacled eiders molt in several discrete areas, with birds from the different populations and genders apparently favoring different molting areas (Petersen et al. 1999). After molting, spectacled eiders from all breeding subpopulations migrate to the central Bering Sea south-southwest of St. Lawrence Island where they spend the winter (Petersen et al. 1999).

Population Status

Little information is available describing the status of the North Slope spectacled eider population prior to the start of the Arctic Coastal Plain population survey in1992. An estimate of 3,000 pairs (6,000 birds) was made for the pre-1993 Arctic Coastal Plain population based on data from limited migration and ground studies (Dau and Kistchinski 1977). At Prudhoe Bay, within the Arctic Coastal Plain breeding area, Warnock and Troy (1992) documented an 80 percent decline in spectacled eider abundance from 1981 until 1991. Since 1992, aerial surveys of eider nesting areas on the Arctic Coastal Plain have been conducted each year. The 2010 Arctic Coastal Plain population index based on aerial surveys was 6,286 birds, which is 4 percent below the long-term 18-year mean. The slight negative growth rate is nearly identical over the long term and most recent 10 years (0.987, 0.974 respectively) (Larned et al. 2011).

Aerial surveys of the wintering area in the Bering Sea were conducted during the winter of 1996–1997, providing a range-wide estimate of the minimum total number of spectacled eiders in late winter of 363,000 (Petersen et al. 1999). Aerial surveys of the wintering areas were repeated in 2009 and 2010. Preliminary results from 2009 indicate a minimum estimate of 302,179 spectacled eiders; data from 2010 have not yet been analyzed (Larned et al. 2009a).

Spring Migration

During spring migration (April to early June) spectacled eiders generally move from the wintering area to staging areas in Russia (Mechigmenskiy Bay on the Chukchi

Peninsula, and the Arctic coast of the western Chukchi and east Siberian seas) and in Alaska (the spring ice lead system offshore of the Yukon-Kuskokwim Delta and Norton Sound, and the Alaska coast of the eastern Chukchi Sea southwest of Barrow) (Sexson, M., USGS-Alaska Science Center, personal communication, 2010). Recent information about spectacled and other eiders indicates that they probably make extensive use of the eastern Chukchi spring lead system. Limited spring aerial observations in the eastern Chukchi have documented dozens to several hundred common and spectacled eiders in open water leads and several miles offshore in relatively small openings in rotting sea ice (U.S. Fish and Wildlife Service 2010).

Breeding

Spectacled eiders arrive on the North Slope in late May or early June. They occur in low densities of approximately 0.17 birds per square kilometer across the North Slope from Wainwright to the Prudhoe Bay area (Larned et al. 2010). The highest concentrations occur within approximately 40 miles of the coast between Barrow and Wainwright, and northeast of Teshekpuk Lake (Larned et al. 2010) (see Map 3.3.8-1). Comparisons of densities in the sampled eider strata show that the strata immediately north of Teshekpuk Lake were highest in 2009 at 0.37 birds per square kilometer. There was a similar pattern in 2008, but prior to that, the densities of spectacled eiders along the Chukchi Coast were normally higher than those north of Teshekpuk Lake. Nesting is believed to occur in the general area of birds observed during aerial surveys, but eider density determined through aerial surveys is not necessarily indicative of actual nest density (Johnson et al. 2006).

In general, on the Arctic Coastal Plain spectacled eiders breed near large shallow productive thaw lakes, often with convoluted shorelines and/or small islands (Larned and Balogh 1997, Anderson et al. 1999). Nest sites are often located within 3 feet of a lake shore (Johnson et al. 1996). Warnock and Troy (1992) reported nests on the Arctic Coastal Plain were initiated in mid-June. Spectacled eider clutch size varies among years and study sites (Petersen et al. 2000). Average clutch size on the Colville River Delta during the period of 1994–1999 was 4.3 eggs per nest (Bart and Earnst 2005). From 1993–2004, average clutch size at CD-3 oil well pad on the Colville River Delta was 4.0 eggs (Johnson et al. 2008). Incubation lasts 20 to 25 days (Kondratev and Zadorina 1992, Moran 1995), and hatching occurs from mid- to late July on the Arctic Coastal Plain (Johnson et al. 2008, Warnock and Troy 1992). Egg hatchability varies over time and among nesting areas. Spectacled eider nest success varies by year and location and is affected by predation from jaegers, common raven (*Corvus corax*), arctic fox (*Alopex lagopus*), and possibly glaucous gulls (*Larus hyperboreus*). Following hatch broods move from nests to freshwater ponds, usually traveling less than 3 kilometers, but occasionally up to 13 kilometers, indicating that not only is the nest site location important, but spectacled eider may also require a much larger area than has been documented in the general vicinity of the nest site for brood-rearing (Petersen et al. 2000). On the nesting grounds, Kondratev and Zadorina (1992) found that spectacled eiders feed on mollusks, insect larvae, small freshwater crustaceans, and plants and seeds in shallow freshwater or brackish ponds, or on flooded tundra. Spectacled eider broods sometimes develop crèches where multiple hens and broods may coalesce (Derksen et al. 1981). Young fledge approximately 50 days after hatch, at which time females with broods move from freshwater to marine habitats.

Post-breeding Migration and Molt

After breeding, spectacled eiders molt in several discrete areas from July to late November, with birds from the different breeding subpopulations and genders favoring different molting areas (Petersen et al. 1999). Late summer and fall molting and staging areas have been identified in eastern Norton Sound (northern Bering Sea) and Ledyard Bay (eastern Chukchi Sea) in Alaska, and in Russia in Mechigmenskiy Bay and an area offshore between the Kolyma and Indigirka River deltas on the Arctic Ocean (Petersen et al. 1999).

Three studies have investigated movements of spectacled eiders from the Arctic Coastal Plain to molting, staging, and wintering locations using satellite telemetry. Troy (2003) monitored spectacled eiders marked at breeding grounds near Prudhoe Bay and Teshekpuk Lake. Ten of 14 males migrated onshore, but parallel to the coast, to reach the Chukchi Sea within 1 to 5 days of leaving breeding areas; 4 males that left later than the others used marine areas of the Beaufort Sea near river deltas for up to 30 days before moving west to the Chukchi Sea (Troy 2003). Females generally departed the breeding grounds later, when much more of the Beaufort Sea is ice-free, allowing for more extensive use of the area. Females spent an average of 2 weeks in the Beaufort Sea (range 6 to 30 days) with the western Beaufort Sea the most heavily used (TERA 2002). Between 1993 and 1996, Peterson et al. (1999) attached transmitters to 88 breeding adults from the three major breeding areas. Four main molting areas were identified by Peterson et al. (1999) with females from the Arctic Coastal Plain primarily using Ledyard Bay and the Indigirka-Kolyma delta region for both molting and staging. In contrast, males from the Arctic Coastal Plain were found to molt and stage at all four areas (Peterson et al. 1999). Sexson (2010) conducted the third study on the Arctic Coastal Plain implanting satellite transmitters in 21 adult eiders in 2009 and 16 adults and 13 juveniles in 2010. In 2009 adult eiders departed the breeding grounds in late June and early August while in 2010 adults and juveniles departed between mid-June and late August (Sexson 2010). In both years, most of the eiders migrated within 40 kilometers of the Beaufort and Chukchi sea coasts of Alaska. In 2009 and 2010, 81 percent of the adults molted in the eastern Chukchi Sea with 17 percent molted on the Arctic coast of Russia and 2 percent molted on the Beaufort Sea coast of Alaska (Sexson 2010). In 2010, juveniles molted in areas along the eastern Chukchi Sea coast (Sexson 2010). Sexson (2010) found that areas used during spring migration in 2010 were the same as those used during fall migration in both years. All females captured on the Arctic Coastal Plain in 2009, and still transmitting locations in spring 2010, returned to breeding sites on the Arctic Coastal Plain while only one male returned to the Arctic Coastal Plain to breed with the remained going to northern Russia (Sexson 2010).

Winter

After molting, spectacled eiders from all breeding subpopulations migrate to the central Bering Sea south-southwest of St. Lawrence Island (Petersen et al. 1999, Sexson 2010), where they remain in large flocks in polynyas until the period between early March and early May (Sexson 2010). In these relatively shallow wintering areas, hundreds of thousands of spectacled eiders rest and feed, diving up to 70 meters to eat bivalves, mollusks, and crustaceans (Lovvorn et al. 2003, Petersen et al. 1998).

Legal Status of Species

The species was listed as threatened under the Endangered Species Act throughout its range in 1993 (U.S. Fish and Wildlife Service 1993), based on the low population estimates and declining trends of the Yukon-Kuskokwim Delta breeding population and a subset (Prudhoe Bay) of the Arctic Coastal Plain breeding population. The size and trend of the Arctic Russia breeding population were unknown at the time of listing. Factors causing the declines were unknown, but a number of potential contributory factors were identified, including subsistence harvest, increased predation due to human activities, consumption of spent lead shot, oil spills or other pollution in the marine environment, effects of large scale fishery fleets on marine ecology, direct mortality in fishing nets or from strikes to fishing vessels, and severe weather.

Critical Habitat

There is no designated critical habitat for spectacled eiders on lands administered by BLM in the NPR-A. The U.S. Fish and Wildlife Service considered designating critical habitat on the North Slope and determined that it provided no additional benefit to the recovery and survival of the species (U.S. Fish and Wildlife Service 2001). Critical habitat has been designated for the spectacled eider in molting areas in Norton Sound and Ledyard Bay, breeding areas in central and southern Yukon-Kuskokwim Delta, and wintering area in waters south of St. Lawrence Island. A total of 100,986 square kilometers (38,991 square miles) is designated as critical habitat for spectacled eiders (U.S. Fish and Wildlife Service 2001).

Steller's Eider

Distribution

The Steller's eider (*Polysticta stelleri*) has a circumpolar distribution. Steller's eiders are divided into Atlantic and Pacific populations; the Pacific population is further divided into the Russian breeding population occurring along the Russian eastern Arctic Coastal Plain and the Alaska breeding population. The range of Steller's eider on the Arctic Coastal Plain apparently once extended from Wainwright east into the Canada's Northwest Territories (Johnson and Herter 1989, Quakenbush et al. 2002). The species is currently reported east at least to Prudhoe Bay (TERA 1997), but no recent records have been reported east of the Sagavanirktok River (Quakenbush et al. 2002). The Alaska breeding population of Steller's eiders now nests primarily around Barrow (see Map 3.3.8-2). The furthest south records of Steller's eiders in NPR-A come from Derksen et al. (1981) who characterized Steller's eiders as common visitors to Singiluk in 1977. After the breeding season, Steller's eiders move to marine waters where they undergo a complete flightless molt for about 3 weeks. The combined Pacific wintering population (which includes populations that breed in eastern Russia and Alaska) molts in numerous locations in southwest Alaska, with exceptional concentrations in four areas along the north side of the Alaska Peninsula: Izembek Lagoon, Nelson Lagoon, Port Heiden, and Seal Islands (Gill et al. 1981, Petersen 1981, Metzner 1993). After molting, many of the Pacific wintering population of Steller's eiders disperse to the eastern Aleutian Islands, the south side of the Alaska Peninsula, and as far east as Cook Inlet (U.S. Fish and Wildlife Service 2002). Prior to spring migration, tens of thousands of Steller's eiders stage in estuaries along the north side of the Alaska

Peninsula and at the Kuskokwim Shoals near the mouth of the Kuskokwim River in late May (Larned 2005, Martin et al., in preparation).

Population Status

Little information is available describing the status of the North Slope Steller's eider population prior to 1992. Because Steller's eiders are uncommon and are apparently episodic breeders on the Arctic Coastal Plain (Rojek 2008), it is difficult to estimate population size or detect population trends of Alaska-breeding Steller's eiders. Stehn and Platte (2009) conducted a review of the distribution, abundance, and trends of the listed population of Steller's eiders on the Arctic Coastal Plain. Using data from three types of aerial surveys (the U.S. Fish and Wildlife Service Arctic Coastal Plain waterfowl survey, the U.S. Fish and Wildlife Service North Slope eider survey, and the ABR Barrow Triangle survey), they assessed the population status and trends of the Steller's eider population nesting on the Arctic Coastal Plain. Data reported from these three surveys provide different estimates of average population size and trend. The 1989–2006 Arctic Coastal Plain survey (Mallek et al. 2007) estimated a total average population size of 866 birds with a declining population growth rate of 0.778 (Stehn and Platte 2009); the North Slope eider survey (1992–2008) (Larned et al. 2009) averaged 162 birds with increasing growth rate of 1.059. The ABR Barrow Triangle survey (1999–2007) (Obrishkewitsch et al. 2008) averaged 100 birds with a growth rate of 0.934. Average population size and trend can be biased by changes in observer, detection rates, and survey timing. Survey timing was considered especially important for species with male departure early in incubation, or other marked shifts in habitat use, movements, or flocking behavior. Using a subset of data least confounded by changes in survey timing and observer, the appropriately-timed North Slope eider survey observations from 1993–2008 averaged 173 indicated total Steller‘s eiders (88–258, 90 percent confidence interval) with an estimated growth rate of 1.011 (0.857–1.193, 90 percent confidence interval). The authors assumed a detection probability of 30 percent, yielding a total average population of Steller‘s eiders breeding in the Arctic Coastal Plain of about 576 (292–859, 90 percent confidence interval) (Stehn and Platte 2009).

The Barrow vicinity supports the largest known concentration of nesting Steller's eiders in Alaska. Standardized ground surveys for eiders near Barrow have been conducted since 1999, and have found an average density near Barrow of 0.63 birds per square kilometer (Rojek 2008). The highest number of Steller's eiders observed during systematic surveys at Barrow occurred in 1999 with 135 males counted during ground surveys (36 nests found); in 2008, 120 male Steller's eiders were counted during ground surveys (28 nests found). Counts of males are the most reliable indicator of Steller's eider presences because females are cryptic and are often undercounted. Approximately 90 percent of all Steller's eiders nests found near Barrow since 1991 are within 1 mile of a road in the vicinity of Barrow (1991–2007 locations are summarized in Rojek [2008]; 2008–2010 locations are summarized in Safine 2011).

Aerial surveys in the Barrow area help to track the abundance and distribution of Steller's eiders that occur outside of the area covered by the ground surveys. Steller's eiders are generally observed in very low densities in the study area in non-breeding years. During breeding years, Steller's eiders have been found widely distributed throughout the survey area, with the highest densities occurring near Barrow (see Map 3.3.8-3). In 12 years of aerial surveys (1999–2010), the 6 highest population estimates for Steller's eiders in the Barrow study area occurred during breeding years (range 96–224 birds) (see Map 3.3.8-3) and the 6 lowest estimates occurred during non-breeding years (range 0–88 birds) (see Map 3.3.8-3) (Obritschkewitsch and Ritchie 2011). What both surveys distinctly show is that the number of Steller's eiders present on the North Slope is highly variable and that the breeding population is concentrated in the area south of Barrow.

Spring Migration

During spring migration, thousands of Steller's eiders stage in estuaries along the north side of the Alaska Peninsula and at the Kuskokwim Shoals near the mouth of the Kuskokwim River in late May (Larned 2007, Martin et al., in preparation). Annual spring aerial surveys were conducted most years from 1992 to 2011, to monitor abundance and habitat associations of Steller's eiders staging for spring migration in southwestern Alaska. Annual Steller's eider estimates ranged from 54,888 (year 2010) to 137,904 (year 1992), with a mean of 81,925 (Larned 2012). The 2011 survey estimate of 74,369 was 9 percent below the 1992-2010 mean, but 35 percent above the 2010 all-time low of 54,888. The long-term trend (1992-2011) indicates an annual decline of 2.3 percent per year (R2=0.34; Larned 2012). Long-term spring aerial survey data indicate a 2.3 percent average annual decline in Steller's eiders observed but the trend since 2002 has been essentially level (-0.7 percent per year; Larned and Bollinger 2011). Larned and Bollinger (2011) suggested that Steller's eiders show strong site fidelity to "favored" habitats during migration, where they congregate in large numbers to feed before continuing their northward migration.

Breeding

Steller's eiders arrive in pairs on Alaska's North Slope in early June. They appear to be episodic breeders; since 1991, Steller's eiders near Barrow apparently nested in 10 years, but did not nest in 7 years (Rojek 2008). Non-breeding years are common in long-lived eider species and are typically related to inadequate body condition (U.S. Fish and Wildlife Service 2006), but reasons for Steller's eiders non-breeding may be more complex. In the Barrow area, Steller's eider nesting has been related to lemming numbers and other environmental cues. Nest success could be enhanced in years of lemming abundance because mammalian predators such as arctic fox are less likely to prey-switch to eider eggs and young, or because avian predators such as pomarine jaegers (*Stercorarius pomarinus*) and snowy owls (*Nyctea scandiaca*) that nest abundantly in high lemming years may protect eider nests from mammalian predators (Quakenbush and Suydam 1999).

On the North Slope, Steller's eider nests are located on tundra habitats, and are often adjacent to small ponds or within drained lake basins. Nests are generally found near the coast, but have been found up to 90 kilometers inland in Alaska (U.S. Fish and Wildlife Service 2002). Nesting habitat in the Barrow area is characterized by low relief, abundance of lakes and ponds, polygonal tundra, and small streams (Quakenbush and Cochrane 1993). Emergent sedge and pendent grass provide important areas for feeding and cover (Quakenbush et al. 1995). Greater than half of the Steller's eider nests found during a study conducted in the Barrow area between 1991 and 1999 were located on rims of low-centered polygons (Quakenbush et al. 2004). Quakenbush et al. (2004) also found that 52 percent of all Steller's eider nests found were closer to ponds with emergent *Arctophila fulva* than waterbodies with other types of emergent vegetation. Also, 44 percent were found near ponds with emergent sedges (mainly *Carex aquatilis*). Average clutch sizes at Barrow varied from 5.3 to 6.3, with clutches of up to 8 reported (Quakenbush 2004). Nest initiation dates for Steller's eiders at Barrow between 1991 and 2007 ranged from June 6 to June 28 (Rojek and Martin 2003, Rojek 2005, 2006, and 2008). Incubation lasts between 24 (U.S. Fish and Wildlife Service 2002) and 27 days (Fredrickson 2001), with hatching occurring from July 7 to August 3 (Quakenbush et al. 1998). As with spectacled eiders, nest and egg loss was attributed to predation by jaegers, common raven, arctic fox, and possibly glaucous gulls (Quakenbush et al. 1995, Obritschkewitsch et al. 2001). Within a day or two after hatch, hens move their broods to adjacent ponds with emergent vegetation, particularly *Carex* spp. and *Arctophila fulva* (Quakenbush et al. 1998, Rojek 2006 and 2007) where they feed on insect larvae and other wetland invertebrates. Broods may move up to several kilometers from the nest prior to fledging (Quakenbush et al. 1998, Rojek 2006). Fledging occurs from 32 to 37 days post hatch (Obritschkewitsch et al. 2001, Rojek 2006).

Post-breeding Migration and Molt

Departure from the breeding grounds near Barrow differs between sexes and between breeding and non-breeding years. However, prior to migration in both breeding and non-breeding years, some Steller's eiders stage close to Barrow in Elson Lagoon, North Salt Lagoon, Imikpuk Lake, and the Chukchi Sea in the vicinity of Pigniq (Barrow Duck Camp). Male Steller's eiders typically leave the breeding grounds after females begin incubating, around the end of June or early July (Quakenbush et al. 1995, Obritschkewitsch et al. 2001). Females that successfully hatched nests and fledged young depart the breeding grounds in late August to mid-September and stage in waterbodies near Pigniq prior to their southward migration along the Chukchi Coast. From mid-July through September single hens, hens with broods, and small groups of two to three birds have been observed in North Saltwater Lagoon, Elson Lagoon, and near shore on the Chukchi Sea. In 2008, 10 to 30 Steller's eider adult females and juveniles were observed daily between late August and mid-September staging in Elson Lagoon, North Salt Lagoon, Imikpuk Lake, and the Chukchi Sea (U.S. Fish and Wildlife Service, unpublished data). Females whose nests fail may also remain near Barrow later in the summer; a single failed-nesting female equipped with a transmitter in 2000 remained near the breeding site until the end of July and stayed in the Beaufort Sea off Barrow until late August (Martin et al., in preparation). In non-breeding years, groups of Steller's eiders are observed just off the Chukchi Sea beach adjacent to Barrow; however, they became absent earlier compared to breeding years and the sex ratios were more even (U.S. Fish and Wildlife Service 2010). During post-breeding migration, Steller's eiders move toward molting areas in the near shore waters of southwest Alaska where they undergo a complete flightless molt for about 3 weeks. The combined (Russia- and Alaska-breeding) Pacific population molts in numerous locations in southwest Alaska, with exceptional concentrations in four areas along the north side of the Alaska Peninsula: Izembek Lagoon, Nelson Lagoon, Port Heiden, and Seal Islands (Gill et al. 1981, Petersen 1981, Metzner 1993).

There is limited information available on the migratory movements of Steller's eiders, particularly in relation to their breeding origin. The best information available is from two satellite telemetry studies of Steller's eiders. One study marked Steller's eiders wintering on Kodiak Island and followed birds through the subsequent spring (n = 24) and fall (n = 16) migrations from 2004–2006 (Rosenberg, 2006). Most of the birds marked on Kodiak returned to eastern arctic Russia during the nesting period, and none of these birds (all presumed to be from the Russian breeding population) were relocated on land or the near shore waters north of the mouth of the Yukon River in Alaska (Rosenberg, 2006). The second study marked birds (n = 14) near Barrow (within the range of the listed Alaska-breeding population) in 2000 and 2001(Martin et al., in preparation). Birds from this study were relocated subsequently along the Arctic coast of Alaska southwest of Barrow to areas near Point Hope, on the Seward Peninsula, and in southern Norton Sound (Martin et al., in preparation). The birds marked near Barrow were also relocated further south in Alaska and in eastern arctic Russia in similar locations to birds marked in Kodiak. Based on the data from two satellite telemetry studies of Steller's eiders in Alaska, birds marked near Barrow (presumably Alaska-breeding Steller's eiders) are the only Steller's eiders that use areas both on shore and in the near shore waters of the Alaska coastline north of the mouth of the Yukon River.

Winter

After molt, many of the Pacific-wintering Steller‘s eiders disperse to areas in the eastern Aleutian Islands, the south side of the Alaska Peninsula, Kodiak Island, and as far east as Cook Inlet, although thousands may remain in lagoons used for molting unless or until freezing conditions force them to move (U.S. Fish and Wildlife Service 2002). During the winter, this species congregates in nearshore waters throughout the Alaska Peninsula and the Aleutian Islands, around Nunivak Island, the Pribilof Islands, the Kodiak Archipelago, and lower Cook Inlet (Larned and Bollinger 2011, Bent 1987, Agler et al. 1995, Larned and Zwiefelhofer 1995). The listed Alaska breeding population is only a small proportion (approximately 0.7 percent) of the Pacific wintering population of Steller's eiders (Stehn and Platte 2009).

Legal Status of Species

The Alaska-breeding population of Steller's eider was listed under the ESA as a threatened species in 1997 (U.S. Fish and Wildlife Service 1997) due to a reduction in the number of breeding birds and suspected reduction in the breeding range in Alaska. Causes for the decline of the Steller's eider population in Alaska may include increased predation pressure on the breeding grounds, harvest, ingestion of lead shot, changes in the marine environment, and contaminants (U.S. Fish and Wildlife Service 2002). Bustnes and Systad (2001) also suggested that Steller's eiders may have specialized feeding behavior that may limit the availability of winter foraging habitat.

Critical Habitat

In 2001, the U.S. Fish and Wildlife Service designated 7,330 square kilometers (2,830 square miles) of critical habitat for the Alaska-breeding population of Steller's eiders at breeding areas on the Y- K Delta, a molting and staging area in the Kuskokwim Shoals, and molting areas in marine waters at Seal Islands, Nelson Lagoon, and Izembek Lagoon (U.S. Fish and Wildlife Service 2001). No critical habitat for Steller's eiders has been designated on lands administered by the BLM in the NPR-A.

Yellow-billed Loon

Distribution

Yellow-billed loons (*Gavia adamsii*) are nearly holarctic in distribution. They nest in the arctic tundra of Alaska on the Arctic Coastal Plain, northwestern Alaska, and St. Lawrence Island; in Canada east of the Mackenzie Delta and west of Hudson Bay; and in Russia on coastal tundra from the Chukotka Peninsula in the east and on the western Taymyr Peninsula in the west (Earnst 2004, North 1994, Red Data Book of the Russian Federation 2001, Ryabitsev 2001, Il'ichev and Flint 1982, Pearce et al. 1998). Their wintering range includes coastal waters of southern Alaska and British Columbia from the Aleutian Islands to Puget Sound (Washington); the Pacific coast of Asia from the Sea of Okhotsk south to the Yellow Sea; the Barents Sea and the coast of the Kola Peninsula; coastal waters of Norway; and possibly Great Britain (Earnst 2004, North 1994, Ryabitsev 2001, Rizzolo and Schmutz 2010, Strann and Østnes 2007, Burn and Mather 1974, Gibson and Byrd 2007).

Population Status

Earnst (2004) estimated the worldwide population of yellow-billed loons to be 16,000 individuals, with approximately 3,300 individuals breeding on the tundra of western and northern Alaska. The 2010 estimate of the population index for yellow-billed loons on the Arctic Coastal Plain is 1,223 birds (Larned et al. 2011a). The population growth rate indicates a positive trend over both the long term (last 19 years) and most recent 10-year reference period (Larned et al. 2010). Distribution in 2010 was similar to that of other years, with two areas of particularly high density. One high-density area is between the Meade and Ikpikpuk rivers and the other is in the areas surrounding Inigok, Fish, and Judy creeks (Map 3.3.8-4). Earnst et al. (2005) calculated that most of the yellow-billed loon population on the Arctic Coastal Plain occurs within concentration areas. Such areas comprised only 12 percent of the surveyed area yet contained 53 percent of all yellow-billed loon sightings. The largest concentration area, between the Meade and Ikpikpuk rivers; it covered only 8 percent of the survey area, but contained 38 percent of yellow-billed loon sightings (Earnst et al. 2005). In aerial lake circling surveys designed specifically for yellow-billed loons, the average density on the Colville River delta (363 square kilometers survey area) was 0.13 individuals per square kilometer during 10 years from 1993 to 2004 and 0.15 to 0.17 individuals per square kilometer from 2005 to 2007 (Johnson et al. 2005, 2006, 2007 and 2008). Similar surveys for yellow-billed loons in a larger area (878 square kilometers) in the northeast portion of the NPR-A in 2001–2004 indicated densities there were lower (0.07 individuals per square kilometer), except that the density in an area adjacent to Fish and Judy creeks was similar to that of the Colville River Delta (Johnson et al. 2005, 2006, and 2007).

Spring Migration

Yellow-billed loons outfitted with satellite transmitters in the NPR-A returned to the breeding grounds by migrating north along the Chukchi Sea coast (Rizzolo and Schmutz 2010) and then gathering in polynyas, ice leads, and early-melting areas off river deltas in spring along the Beaufort Sea Coast (Johnson and Herter 1989). Most of the yellow-billed loons nesting in the NPR-A start spring migration in April and arrive on breeding grounds in the first half of June with the average date of the first inland location being

June 9 (Rizzolo and Schmutz 2010). Yellow-billed loons were located within 30 kilometers of shore in the Chukchi Sea during spring migration (Rizzolo and Schmutz 2010).

Breeding

Yellow-billed loons nest exclusively on margins of lakes and islands in coastal and inland low-lying tundra from latitude 62° to 74° N. Yellow-billed loons are sparsely distributed during the breeding season, and are somewhat clumped at a large scale, perhaps because of non-uniform habitat quality. Within Alaska, there are two breeding areas—the North Slope region and the region surrounding Kotzebue Sound in northwest Alaska (Earnst 2004, North 1994). Highly convoluted shorelines and those with aquatic vegetation provide loon nesting and brood-rearing sites, as well as fish habitat. Yellow-billed loons use nearshore and offshore marine waters adjacent to their breeding areas for foraging in summer. Such habitats are likely used by both breeding adults and younger or non-territorial birds (Earnst 2004). Of the eight yellow-billed loons marked with satellite transmitters in the NPR-A in 2008, seven returned in 2009 to vicinity of the lake where they were first captured (Rizzolo and Schmutz 2009). Hatching occurs after 27 to 28 days of incubation by both sexes. The age at which young are capable of flight is probably similar to common loons (8 to 9 weeks, possibly up to 11). Young leave the nest soon after hatching, and the family may move between natal and brood-rearing lakes. Both parents feed and care for young (North 1994).

Ground-based surveys in 1983 and 1984 found 76 and 79 percent of territorial pairs nesting, respectively (Field et al. 1993). The same territories studied in 1983 and 1984 were visited in 1989 and 1990, and 42 percent and 67–71 percent, respectively, of the territorial pairs were found nesting (Field et al. 1993, North 1993). The percentage of territorial pairs nesting ranged from 39 to 89 percent during a 6-year ground-based study (1995–2000) (Earnst 2004).

Information on reproductive success is limited, but significant inter-annual variation has been described. Territory occupancy and nesting success of yellow-billed loons has been studied on the Colville River delta during 19 years (1992–2010) and in the northeast portion of NPR-A during 1999–2010 (Johnson et al. 2010). Apparent nest success on the Colville River delta recorded by aerial surveys ranged from 19 to 64 percent between 1993 and 2009 (Johnson et al. 2010). Johnson et al. (2010) found the third highest number of yellow-billed loon nests (30) in the Colville Delta study area since aerial surveys began in 1993, but less than half of those nests hatched young. Apparent nesting success for yellow-billed loons on the Colville Delta in 2009 was the lowest since monitoring surveys began in 2005 for an apparent nesting success of 43 percent while at the NPR-A site apparent nesting success was 52 percent (Johnson et al. 2010). Cameras document nest predation by red foxes, brown bear, glaucous gulls, and parasitic jaeger (Johnson et al. 2010). The count of 13 broods in the Colville Delta study site in 2009 was equal to the 15-year average, but low compared to the number recorded in 2005–2008 (range 16–27 broods). In the NPR-A study area 15 broods were detected in 2009 (Johnson et al. 2010). Studies of survival rates to an age of 6 weeks for yellow-billed loons on the Colville River delta from 1995–2000 ranged from 4 to 60 percent (Earnst 2004), with low success attributed to late ice melt or extreme flooding.

Earnst et al. (2006) modeled yellow-billed loon habitat preferences in a 23,500-square-kilometer area of northern Alaska using intensive aerial surveys and landscape-scale habitat descriptors. Yellow-billed loons were found to occupy 15 percent of the 757 lakes surveyed (Earnst et al. 2006). Lake area, depth, proportion of shoreline in aquatic vegetation, shoreline complexity, and hydrological connectivity (stream present within 100 meters or absent), were found to be significant predictors of yellow-billed loon presence. Distance to nearest river or Beaufort Sea coast were not found to be significant (Earnst et al. 2006). Predicted yellow-billed loon presence was 13 and 4.7 times more likely on deep and medium lakes, respectively, than on shallow lakes that freeze to the bottom (Earnst et al. 2006). Yellow-billed loon adults feed their young almost entirely from the brood-rearing lake (North 1994) and are dependent on fish being available in the brood-rearing lake. Johnson et al. (2009) found that at both their Colville River and NPR-A study sites that no shallow water habitats were used during brood rearing and that selection analyses for nesting and brood rearing affirms the importance of large, deep waterbodies to breeding yellow-billed loons.

An investigation into the concentrations and effects of contaminants on yellow-billed loons breeding in the NPR-A, including an assessment of contaminant concentrations in eggs and adults (using feathers and blood) was conducted in 2007 and 2008. There was particular concern about polychlorinated biphenyls in eggs due to findings of toxic concentrations in eggs of red-throated loons nesting on the Arctic Coastal Plain (Schmutz et al. 2009). The most toxic polychlorinated biphenyls were not detected in yellow-billed loons sampled in the NPR-A (Matz 2010). Although other polychlorinated biphenyls congeners were detected, the absence of the toxic congeners makes the total polychlorinated biphenyls concentrations of low concern. While total mercury was detected in all whole blood samples analyzed, mean concentrations were well below levels associated with reproductive failure in common loons (Matz 2010, Evers et al. 2007). Feather and egg mercury levels were also well below the toxic threshold for common loons (Matz 2010, Evers et al. 2007). Fish of suitable size to be yellow-billed loon prey items have been collected from lakes were loons are known to nest and those samples have been submitted for contaminants analysis (Matz 2010).

Post-breeding Migration

Yellow-billed loons generally follow the Chukchi Sea coast of Alaska within 30 kilometers from land during migration with locations concentrated in Peard Bay, Wainwright Inlet, Kasegaluk Lagoon, Ledyard Bay, Cape Lisburne, and Point Hope (Rizzolo and Schmutz 2010). The vast majority of yellow-billed loons breeding on the Arctic Coastal Plain in Alaska have been found to migrate to Asia, predominantly using a route south along the Russian coastline from the Chukotka Peninsula and along the Kamchatka coast (Rizzolo and Schmutz 2010). Birds from the NPR-A departed inland (breeding) locations between late June and late September with some early departing birds spending up to 90 days in the Chukchi Sea prior to migration (Rizzolo and Schmutz 2010). Of 15 birds outfitted with satellite transmitters at Darling Lake in Northwest Territories, Canada, only one used the Beaufort and Chukchi sea coasts of the NPR-A during migration (Schmutz, J., personal communication 2010).

Winter

Yellow-billed loons breeding in NPR-A have been found to winter in the Yellow Sea and Sea of Japan off China, North Korea, Russia, and Japan (Rizzolo and Schmutz 2010). Other known wintering areas for yellow-billed loons include the Commander Islands, Russia, Unimak Island in the Aleutian Island chain (Rizzolo and Schmutz 2010) and coastal waters of southern Alaska and British Columbia from the Aleutian Islands to Puget Sound; the Barents Sea and the coast of the Kola Peninsula; coastal waters of Norway; and possibly Great Britain (Earnst 2004, North 1994, Ryabitsev 2001, Strann and Østnes 2007, Burn and Mather 1974, Gibson and Byrd 2007). Rizzolo and Schmutz (2010) found that throughout the winter season, yellow-billed loons marked with satellite transmitters were located within 30 kilometers of shore. Most yellow-billed loons arrive in wintering locations in mid-November and Rizzolo and Schmutz (2010) found that birds that were captured as pairs in Canada during the breeding season were not found together on the wintering grounds.

Legal Status of the Species

On March 25, 2009, the yellow-billed loon was designated a candidate for protection under the ESA because of its small population size rangewide and concerns about levels of subsistence harvest and other potential impacts to the species (U.S. Fish and Wildlife Service 2009). This finding resulted in a determination that listing under the ESA is “warranted but precluded” by higher priority listing actions. The yellow-billed loon is also listed by the U.S. Fish and Wildlife Service as a species of conservation concern in the Arctic Plains and Mountains bird conservation region. Yellow-billed loons are vulnerable to population decline due to a combination of small population size, low reproductive rate, and very specific breeding habitat requirements.

Critical Habitat

There is no critical habitat designated for yellow-billed loons.

Kittlitz’s Murrelet

Distribution

All of the North American and a large proportion of the known world population of Kittlitz’s murrelets (*Brachyramphus brevirostris*) breed, molt, and winter in Alaska (Day et al. 1999). An estimated 10 percent of the world population breeds in the Russian Far East from the Okhotsk Sea to the Chukchi Sea (Day et al. 1999). In Alaska, Kittlitz’s murrelets primarily occur in four regions: Southeast, Southcentral, the Aleutian Islands, and the Alaska Peninsula. Historically, Kittlitz’s murrelets inhabited coastal waters discontinuously from Barrow south to northern portions of Southeast Alaska (Day et al. 2010). Prior to the 1970s, Kittlitz’s murrelets in the northern Gulf of Alaska were estimated to number in the hundreds of thousands (Isleib and Kessel 1973). Large numbers were observed along the Lisburne Peninsula during the early 1970s (Day et al. 1999), suggesting that notable numbers of birds occurred in the Chukchi Sea at that time. Marine surveys for Kittlitz’s murrelets have not been conducted in the Chukchi Sea off Cape Lisburne since the early 1970s, but a nest was found at Cape Lisburne in 1995 (Day and Stickney 1996). Surveys in the waters off Kodiak Island indicate that Kittlitz’s murrelets are year-round residents there (Stenhouse et al. 2008). A recent report of Kittlitz’s murrelet distribution and status in northern Alaska (Day et al. 2010) summarizes known sighting of murrelets and their nests in the northern part of their range (the marine portion of which spans the area from the Bering Strait to the Arctic Ocean and east to the U.S.-Canada border, an area which encompasses the near shore marine areas of the entire planning area). In this northern marine area, the species was found in the Chukchi Sea from mid-April to mid- or late October (Day et al. 2010).

Population Status

Based on information from various locations from 1999 to 2008, the current Alaska population estimate of the Kittlitz's murrelet is 19,578 birds (range = 8,190–36,193). Day et al. (2010) estimates 5,200 birds in northern Alaska, with the only known areas of bird concentration close to or in the planning area being at Peard Bay, in the vicinity of Barrow, and at-sea in the Barrow Canyon. Considering population estimates for all known areas of occurrence, the worldwide population of Kittlitz's murrelets is estimated to be 24,678 individuals (U.S. Fish and Wildlife Service 2009). Day et al. (2010) were unable to determine any trend in the population of Kittlitz's murrelets in northern Alaska.

Spring Migration

Migration routes of Kittlitz's murrelets into the Arctic are unknown.

Breeding

Kittlitz's murrelets nest solitarily on the ground in remote areas (Day 1995, Day et al. 1999). Typical nesting habitat in Alaska is believed to be unvegetated scree-fields, coastal cliffs, barren ground, rock ledges, and talus above timberline in coastal mountains, generally in the vicinity of glaciers, cirques near glaciers, or recently deglaciated areas, primarily from the Alaska Peninsula to Glacier Bay (Day et al. 1983, Day 1995, Day et al. 1999, Piatt et al. 1999). Until the late 1990s, only about two dozen records of nests existed (Day et al. 1983, Day 1995, Day et al. 1999). In 2005, 2006, and 2008, Kittlitz's murrelet nests were discovered on the mountainous scree slopes of Agattu Island, a far western Aleutian Island. In 2006 and 2008, nests were located on Kodiak Island, none of which fledged young (Burkett and Piatt 2008, Stenhouse et al. 2008). In 2007, seven nests were found in the area surrounding Icy Cape in southeast Alaska (Kissling et al. 2007). Day et al. (2010) compiled records of nine nests in northern Alaska, all of which occur south of the planning area. During the breeding season, Kittlitz's murrelets appear to favor waters less than 200 meters from shore (Day et al. 2000), although a recent study suggests oceanic topography, rather than distance to shoreline, may be a more biologically meaningful parameter (Kissling et al. 2005). Juvenile recruitment of Kittlitz's murrelets remains largely unobserved, despite intense survey effort (Day and Nigro 1999, Kissling, M., U.S. Fish and Wildlife Service, Juneau, Alaska, personal communication).

Post-breeding Migration

Migration routes of Kittlitz's murrelets out of the Arctic are unknown.

Winter

The winter range of the Kittlitz's murrelet is not well known. There are records of occasional winter sightings in southeast and western Alaska, and locally common sightings in the protected waters of Prince William Sound, Kenai Fjords, Kachemak Bay, Kodiak Island, and Sitka Sound (Kendall and Agler 1998, Day et al. 1999, Stenhouse et al. 2008). They have also been reported during winter in the mid-shelf regions of the northern Gulf of Alaska (Day and Prichard 2001) and in the offshore waters of along the Aleutian Islands (Gibson and Byrd 2007). The winter range of the species outside North America is largely unknown, but observations have been reported from the Kamchatka Peninsula and the Kuril Islands in the Russian Far East (Flint et al. 1984).

Legal Status of the Species

On May 4, 2004, the Kittlitz's murrelet was designated a candidate for protection under the ESA because of its small population size range-wide, and concerns about global climate change and other potential impacts to the species (U.S. Fish and Wildlife Service 2004). This finding resulted in a determination that listing under the ESA as threatened was "warranted but precluded" by higher priority listing actions. Kittlitz's murrelets are vulnerable to population decline due to a combination of climate change and de-glaciation, mercury and petroleum contamination, disturbance by tour boat traffic, bycatch in commercial gillnet fisheries, avian predation, and low recruitment (U.S. Fish and Wildlife Service 2004).

Critical Habitat

There is no critical habitat designated for Kittlitz's murrelet.

Red Knot

Distribution

The red knot (*Calidris canutus*) is a medium-sized Arctic-breeding shorebird. Six subspecies of red knots are currently recognized worldwide based on small differences in body dimensions and breeding plumage characteristics, and discrete breeding areas and migration routes (Piersma and Baker 2000, Niles et al. 2008). The subspecies of red knot that occurs in NPR-A is C. c. roselaari (referred to in the remained of this document as the red knot) which breeds in Alaska and on Wrangel Island, Russia (Tomkovich 1992), and is the only red knot subspecies known to nest in the U.S. Breeding distribution within Alaska is only generally known and includes the Seward Peninsula and inland areas north of Kotzebue, including the DeLong Mountains of the Brooks Range (Childs 1969, Kessel 1989, Kessel and Gibson 1978, Harrington 2001). Within NPR-A the red knot is a rare migrant on both the Chukchi and Bering sea coasts (Kessel and Gibson 1978, Johnson and Herter 1998) and has been found breeding in small numbers near Barrow (Pitelka 1974). Niles et al. (2008) have identified recent information that indicates the red knot is largely or wholly confined to the Pacific coast of the Americas during migration and in winter.

Population Status

Historical and current population size of the red knot is uncertain and the trend is unknown. Although the red knot is considered to be largely or wholly confined to the Pacific coast of the Americas on migration and in winter (Niles et al. 2008), limited data exist from sites known to be used by this subspecies. The breeding population in Alaska is at most a few thousand birds scattered across northern and northwestern Alaska[18]. The U.S. Fish and Wildlife Service has included the red knot on their Birds of Conservation Concern list for the Arctic Plains and Mountains bird conservation region.

Spring Migration

A larger number of red knots migrate through Alaska en route to Siberian breeding grounds, presumably Wrangel Island (Harrington 2001). During migration only a few primarily stopover sites are used, the most important of which are Grays Harbor and Willapa Bay in Washington, and Yukon-Kuskokwim Delta and Copper River Delta in Alaska (Isleib 1979, Gill and Handel 1990, Page et al. 1999). During migration stopovers red knots are primarily found in coastal habitats, particularly in areas with extensive sandy intertidal flats or near tidal inlets or mouths of bays and estuaries (Harrington 2001).

Breeding

Pitelka (1974) described the red knot as occurring regularly and as being a breeder along the Beaufort and Chukchi sea coasts. Derksen et al. (1981) describes the red knot as a casual visitor at their study site in NPR-A. The red knot's diet on the breeding grounds consists primarily of terrestrial invertebrates, but early in the breeding season they may consume a substantial amount of plant material, such as grass shoots and seeds (Kessel 1989, Harrington 2001).

Post-breeding Migration

Post-breeding migration routes are uncertain as the use of stopover sites is unclear, as the migration is protracted and large concentrations are not reported in fall at sites used during spring (U.S. Fish and Wildlife Service 2011). Niles et al. (2008) report that the red knot is largely or wholly confined to the Pacific coast of the Americas during migration. Red knots are known to undertake long flights during migration that may span thousands of miles (Harrington 2001); thus during fall migration they may bypass sites used in spring. During migration stopovers red knots are primarily found in coastal habitats, particularly in areas with extensive sandy intertidal flats or near tidal inlets or mouths of bays and estuaries (Harrington 2001).

Winter

Important wintering aggregations of red knot have been documented in western Mexico at Guerrero Negro, Baja California Sur (Carmona et al. 2006), and the Pacific Northwest coast of Mexico in the Gulf of California at Ensenada Pabellones and Bahia Santa Maria, Sinaloa (Engilis et al. 1998). Niles et al. (2008) have identified recent information that indicates the red knot is largely or wholly confined to the Pacific coast of the Americas during winter. On wintering areas, red knots are primarily found in coastal habitats, particularly in areas with extensive sandy intertidal flats or near tidal inlets or mouths of bays and estuaries (Harrington 2001).

Legal Status of the Species

On January 4, 2011, the red knot was determined to not warrant protection under the ESA because the petition did not present substantial information that the petitioned actions may be warranted and particularly due to the fact that no specific information was provided on threats to the species by the petitioner (U.S. Fish and Wildlife Service 2011).

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[18] http://alaska.fws.gov/mbsp/mbm/shorebirds/species/Red-Knot.htm.

Critical Habitat

There is no critical habitat designated for red knot.

Short-eared Owl

Distribution

The short-eared owl (*Asio flammeus*) is one of the world's most widely distributed owls inhabiting marshes, grasslands, and tundra throughout much of North America and Eurasia. It also breeds in South American grasslands and on islands such as Iceland, the Hawaiian chain, and the Galápagos. The North American population winters from northern Mexico to southern Canada and uses open habitats year-round to feed on microtines and other small mammals (Wiggins et al. 2006). In Alaska, the species breeds at low densities in tundra and wetlands habitats. Limited band recoveries from Canada and the contiguous United States suggest the species may use multiple flyways depending on breeding location.

Population Status

The Alaska population is estimated at 150,000 birds (Booms, T., personal communication), but the population status of this species is difficult to assess because they are prone to annual fluctuations in numbers; also contributing to difficulties are the species nomadic nature, crepuscular habits, and overall low abundance. The species is considered to be highly migratory in Alaska, with small numbers found year-round in coastal wetlands in southeast Alaska (Wiggins 2008). Concentrations of birds have been noted during highs in the microtine cycle near Barrow (Pitelka et al. 1955a), Yukon Delta (Nelson 1877), Copper River Delta, and Juneau. The short-eared owl has undergone a steep, long-term, and rangewide decline of about a 71 percent in population size since 1966 (Sauer et al. 2005). Unlike temperate areas, breeding habitats for short-eared owls in Alaska are relatively intact. Alaskan short-eared owls are most threatened by conversion and fragmentation of temperate grasslands and wetlands habitat conversions on their wintering grounds (Wiggins 2008).

Spring Migration

Although considered to be highly migratory in the northern portion of their range the spring migration routes of Alaska's short-eared owls are unknown.

Breeding

At Barrow, Pitelka (1974) listed the short-eared owl as an occasional breeder both along the coast and inland and found that large, annual fluctuations in their numbers were tightly correlated with the abundance of small mammals (Pitelka et al. 1955a, b). Studies of birds conducted in the northern portion of the planning area in the 1970s and 1980s reported observations of short-eared owls as visitors each year, but no nests were found (Derksen 1981, Simpson et al. 1982, Renken et al. 1983, North et al. 1984). During 6 years of field studies on the Colville River Delta, Johnson et al. (2003) found only one short-eared owl nest. Liebezeit and Zack (2006, 2007, 2008) found short-eared owls to be abundant on their study site in 2006 (a high lemming year), but uncommon in 2007 and 2008; no nests were found in any of the years of their study. Being a ground nesting bird, predation of eggs and young by jaegers, gulls, and foxes likely influences productivity in years when small mammal populations are low.

Post-breeding Migration

The locations of wintering areas of Alaska's short-eared owls are just beginning to become known. A multi-year study initiated in the summer of 2009 found that owls captured in Nome and Interior Alaska followed two distinct pathways out of Alaska. The first route followed the Tanana River valley out of Alaska and into the Yukon Territories and British Columbia Canada after which most of the owls moved through Alberta, Canada, and the central prairie states of the U.S. or along the eastern front of the Rocky Mountains. The second route was coastal from Seward and Anchorage down through British Columbia and into Washington, Oregon, and California (Johnson, J., Booms, T., personal communication).

Winter

The locations of wintering areas of Alaska's short-eared owls are just beginning to become known. A multi-year study initiated in the summer of 2009 found that owls captured in Nome and Interior Alaska wintered across 33° of latitude and 23° of longitude, from California to Texas and Alberta, Canada, to central Mexico (Johnson, J., Booms, T., personal communication).

Golden Eagle

Distribution

Golden eagles (*Aquila chrysaetos*) occur over much of the northern hemisphere. In North America, they are found mainly in western regions from Alaska south to central Mexico. Within Alaska, the golden eagle is found nesting in habitat dominated by rugged topography or mountainous terrain, near or above timberline, and along riparian areas (Ritchie and Curatolo 1984, Petersen et al. 1991, Young et al. 1995) from the north slopes of the Brooks Range south throughout most of Alaska (Kochert et al. 2002). The northern foothills of the Brooks Range appear to be the northern limit of the breeding range of the golden eagle (Johnson and Herter 1989, Young et al. 1995). Subadult golden eagles are known to frequent the Arctic Coastal Plain during spring and summer although they appear to be more common to the east of the planning area (Johnson and Herter 1989). Juvenile golden eagles have been tracked from Denali National Park and Preserve to the planning area using satellite telemetry. One subadult eagle spent over 2 months in the northwestern portion of the NPR-A (McIntyre, C., personal communication). Two others spent less than a month in the southern portion of the NPR-A (McIntyre, C., personal communication).

Population Status

Declines in nesting populations have been shown for golden eagles in the western United States but not for those breeding in Alaska and Canada (Kochert and Steenhof 2002). Within the NPR-A, golden eagles are found in the foothills of the Brooks Range and along the coastal plain, but breed regularly only in the foothills (Johnson and Herter 1989, Ritchie et al. 2003). Aerial surveys were conducted in the NPR-A in 1977 and 1999 with the goals of locating and inventorying cliff-nesting raptors. The number of golden eagle nest sites located in the planning area was greater in 1999 than in 1977, but in each year less than half of the detected nests were occupied. Ten and 11 occupied nest sites were located in 1977 and 1999, respectively (Ritchie et al. 2003). Distributions of nest sites between the two survey periods were similar, and the majority of nests were located in the southern foothills of the Brooks Range (Ritchie et al. 2003). The 1999 survey located 71 percent of all golden eagle nests found in the NPR-A on the Kiligwa, Kuna, and Utukok rivers (Ritchie et al. 2003) (see Map 3.3.8-5). The most northerly nests located during either survey period were found on the Utukok River and its tributary, Carbon Creek (Ritchie et al. 2003).

Spring Migration

Golden eagles outside of Alaska do not migrate, but most populations in interior and northern Alaska are migratory (Kochert et al. 2002). Migration routes for golden eagles breeding in the NPR-A are not known.

Breeding

The 1999 aerial raptor survey conducted in the planning area detected 1.2 young per successful pair (Ritchie et al. 2003). This number is similar to results from studies conducted in the Arctic National Wildlife Refuge (1.1– 1.3 young/successful pair) (Young et al. 1995) and in the Northwest Territories (1.1–1.5 young/successful pair) (Poole and Bromley 1988). Golden eagle nests were most often found on the largest cliffs associated with rivers in the southern portion of the NPR-A (Ritchie et al. 2003). Arctic ground squirrels (*Spermophilus parryii*), snowshoe hares (*Lepus americanus*), and arctic hares (*Lepus arcticus*) are the principal prey species in Alaska and northern Canada (Poole and Bromley 1988). Prey remains recorded at golden eagle nests located on the north slope of the Brooks Range in the Arctic National Wildlife Refuge included arctic ground squirrel (*Spermophilus parryii*), Dall sheep (*Ovis dalli*), caribou, willow ptarmigan (*Lagopus lagopus*), rock ptarmigan (*Lagopusm utus*), short-eared owl, and common raven (*Corvus corax*) (Young et al. 1995).

Post-breeding Migration

Golden eagles outside of Alaska are non-migratory, but most populations in interior and northern Alaska are migratory (Kochert et al. 2002). Migration routes for golden eagles breeding in the NPR-A are not known. Golden eagles from Denali National Park in interior Alaska follow the Rocky Mountains south terminating migration anywhere from central Alberta down into northern Mexico (Kochert et al. 2002).

Winter

The winter range of golden eagles breeding in the planning area is unknown. Golden eagles breeding in Denali National Park in interior Alaska are found wintering from central Alberta, Canada, into northern Mexico. Some eagles may overwinter in interior and northern Alaska when high numbers of snowshoe hares are available (Kessel 1989).

Special Status Species of Birds and Climate Change

Bird habitats worldwide are threatened by climate change, though species for which breeding is restricted to the arctic regions may be the most vulnerable to climate change.

The spectacled and Steller's eider, yellow-billed loon, and red knot are all considered to be arctic region breeders and so their populations may be especially vulnerable to climate change. Of the species described in section 3.3.8.2, the two eider species—yellow-billed loon and to a lesser extent the red knot—are also vulnerable to population decline due to various combinations of small population size, low reproductive rate, very specific breeding habitat requirements, very few known breeding locations (Steller's eider), predation pressure, and changes in the marine environment. Short-eared owl and golden eagle have circumpolar distributions with breeding ranges that vary from high latitude tundra to widely distributed across Alaska with the NPR-A being the northern extent of their breeding range; thus their populations are less at risk by climate change. The Kittlitz's murrelet is found in very low numbers in the nearshore waters of the Chukchi Sea adjacent to the NPR-A and is not thought to breed in the planning area. The climate change scenario presented in this document (Scenarios Network for Alaska Planning 2010) predicts that for the rest of the 21st century temperature and precipitation will increase but that longer, warmer summers will increase evapotranspiration so that there will actually be less moisture available to plants and the potential for many shallow streams, ponds, and wetlands in the Arctic to dry out under a warming climate is increased by the loss of permafrost. These shallow systems depend on snowmelt as their primary source of water, with rainfall gains often negated by evapotranspiration during the summer. Evaporation from these shallow waterbodies is very likely to increase as the ice-free season lengthens. Hence, the water budget of most lake, pond, and wetland systems is likely to depend more heavily on the supply of spring meltwater from winter precipitation to produce a positive annual water balance, and these systems are more likely to dry out during the summer (Arctic Climate Impact Assessment 2004).

The following discussion touches only on very broad changes in bird habitats and associated food resources that might occur if the modeled future trends are fairly accurate. The processes that are likely to have the greatest effect on bird populations in the planning area are (Martin et al. 2009) (1) abundance and distribution of surface water, (2) vegetation community changes, (3) invertebrate community changes, and (4) coastal process and habitats.

The abundance and distribution of surface water is of crucial importance to many of the bird species described in this section as the nesting and foraging habitats of the spectacled and Steller's eider, yellow-billed loon, and red knot are restricted to the aquatic and semi-aquatic habitats. Increased summer temperatures could lead to the conversion of aquatic habitats into dryer habitat types resulting in a loss of not only habitat quantity but also habitat quality in terms of potential decrease in food resources (invertebrate and plant). This loss of quantity and quality would likely lead to changes in bird distributions which might in turn lead to increased competition for limited resources and associated decreases in productivity.

Section 3.3.1.4 outlines the changes that may occur in vegetation communities if climate change predictions are correct. These include changes in the vegetation species composition of the tundra leading to increases in shrub extent and height with increased grasses and sedges in some areas, at the expense of mosses and lichens. Warmer soil temperatures are likely to increase thermokarst activity, and increases in sea level may inundate low-lying areas, increasing salt marsh extent, aquatic, and wet tundra vegetation types, and erosion of coastal bluffs (Arctic Climate Impact Assessment 2004). Significant changes in plant communities of the NPR-A may be expected especially in the southern foothills and mountains. Increases in shrub height and extent could have varying effects on the short-eared owl and golden eagle populations that nest in that area. There could be a positive effect for shrub associated passerines, ptarmigan, and their predators (golden eagles and short-eared owls) and a negative effect in terms of productivity and abundance for wetland adapted species (red knot, yellow-billed loon, spectacled eider, Steller's eider) if their habitat is reduced by the encroachment of shrubs. Changes in plant phenology due to warming temperatures may result in an increase in plant biomass, but a decrease in plant quality in relation to forage for birds. There is also the potential that the timing of emergence of high quality forage and the timing of the greatest energy needs of the birds might be offset if the timing of vegetation growth changes independently of the timing of the nutritional needs of the birds.

Impacts to the bird community may occur if warmer spring temperatures advance snowmelt, which is closely associated with insect emergence, and result in changes in the timing and patterns of insect emergence and peak abundance to which the birds may not be able to compensate. This potential disconnect between invertebrate abundance and bird nutritional needs may cause decreases in bird productivity and survival (Tulp and Schekkerman 2008) and have a negative effect on bird body condition during the molt and pre-migration periods resulting in birds being in poorer condition during the fall migration and winter periods. Redistribution of water into newly created thermokarst areas may result in an increase in invertebrate productivity and lead to an increase in the productivity, abundance, and distribution of some species of birds. However, if climate change causes drying of currently saturated soils and shallow wetlands then invertebrate populations may decrease leading to a decrease in the productivity, abundance, and distribution of some species of birds.

Loss of barrier islands and changes to the salinity and temperature regimes of protected coastal lagoons due to climate change driven factors could have negative effect on those birds that use these areas for pre-breeding staging (Steller's and spectacled eider, yellow-billed loon) and pre/post migration staging (red knot, yellow-billed loon, Steller's eider). The increase in coastal erosion that is predicted to occur due to climate change has the potential to significantly decrease the quantity and quality of habitat of terrestrial habitat within the planning area resulting in a decrease in the foraging, nesting, brood-rearing and staging habitats spectacled and Steller's eider, yellow-billed loon and red knot. Increases in sea level and storm surges may affect coastal habitats including mud flats, wet sedge coastal tundra, and salt-killed tundra.

3.3.8.3 Terrestrial Mammals

Of four species of terrestrial mammals currently listed as sensitive by the BLM-Alaska (Appendix F), only the Alaskan hare (*Lepus othus*) has been known to occur in the NPR-A (MacDonald and Cook 2009). Historically, the subspecies *L. othus othus* was present on the North Slope west of the Colville River, but there have been no further reports of this species on the North Slope since 1951 (Klein 1995). Its decline there may have coincided with the arrival of the snowshoe hare. Its current known distribution is from the Yukon-Kuskokwim Delta northward to Norton Sound. The subspecies *L. o. poadromus* occurs from Bristol Bay through the Alaska Peninsula. *L. o. othus* occurs in tundra and alluvial plains habitats.

The Alaska tiny shrew (*Sorex yukonicus*) is a newly described species (Dokuchaev 1997). It appears to be widespread but scarce across Alaska. Only two specimens have ever been collected on the North Slope. A single individual was collected in the northern foothills of the Brooks Range east of the NPR-A (Cook and MacDonald 2004). Another was found dead in 2004 near the mouth of the Canning River (MacDonald and Cook 2009). The BLM has never conducted surveys for this species in the NPR-A, and no other mammalogist has published a record of this species from the NPR-A. Although its habitat needs are poorly documented, the species has been found in a wide range of forested and non-forested habitats, and most commonly in riparian scrub. It is possible these habitat needs could be met within the NPR-A foothills if this species has sustained a population just east of the NPR-A.

3.3.8.4 Marine Mammals

Bowhead Whale

The bowhead whale (*Balaena mysticetus*) is classified as endangered under the ESA and as depleted under the Marine Mammal Protection Act. The bowhead whale was listed as endangered in 1970 (U.S. Fish and Wildlife Service 1970), but no critical habitat has been designated for this species. Because of their ecological and cultural importance in the U.S. Arctic, a detailed description follows.

Until recently, the scientific literature had long suggested that bowhead whales were divided into five discrete stocks across the circumpolar Arctic; Svalbard, Davis Strait, Hudson Bay, Bering-Chukchi-Beaufort Seas, and Sea of Okhotsk (Figure 3.3.8-1) However, recent satellite telemetry data suggests the Hudson's Bay and Davis Strait stocks are functionally one stock (Heide-Jorgensen et al. 2008). The Bering-Chukchi-Beaufort Seas stock of bowhead whales is considered the largest of the stocks (Figure 3-9) (Koski et al. 2010, Angliss and Outlaw 2005). The size of the Bering-Chukchi-Beaufort Seas stock was estimated at 10,400 to 23,000 animals in 1848, before commercial whaling decreased the stock to between 1,000 and 3,000 animals by 1914 (Woodby and Botkin 1993). Brandon and Wade (2006) suggested a lower estimate for the pre-exploitation population size of closer to 14,000 animals. This stock has slowly increased since 1921 when commercial whaling ended, and in 2001 estimates indicated a population size of about 10,500 whales (George et al. 2004, Zeh and Punt 2005). The most current (2004) abundance estimate is not based on an ice-based migratory count as has been the case since 1978; instead a photo capture-recapture technique was used. The abundance of the Bering-Chukchi-Beaufort Seas bowhead population in 2004 was estimated to be 12,631 with a coefficient of variation 0.244, 95 percent confidence interval (7,900; 19,700) and 5 percent lower limit of 8,400 (Koski et al. 2010). Separate analyses suggest the mean annual rate of increase from 1978 to 2001 to be between 3.4 and 3.5 percent (George et al. 2004, Brandon and Wade 2004).

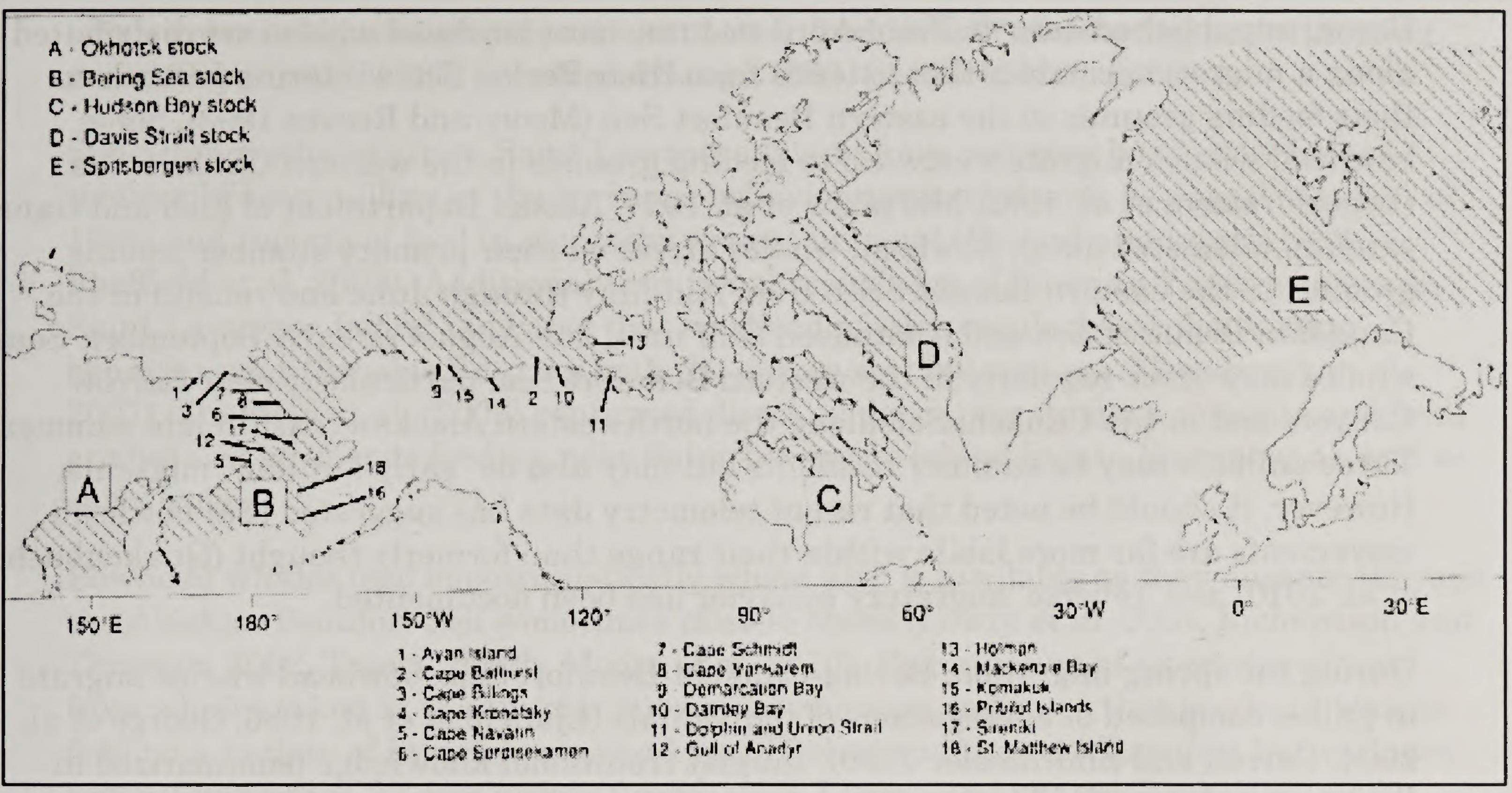
A - Okhotsk stock
B - Bering Sea stock
C - Hudson Bay stock
D - Davis Strait stock
E - Spitsbergen stock
A
B
C
D
E
150°E
180°
150°W
120°
90°
60°
30°W
0°
30°E
1 - Ayan Island
2 - Cape Bathurst
3 - Cape Billings
4 - Cape Kronotsky
5 - Cape Navarin
6 - Cape Serdtsekamen
7 - Cape Schmidt
8 - Cape Vankarem
9 - Demarcation Bay
10 - Darnley Bay
11 - Dolphin and Union Strait
12 - Gulf of Anadyr
13 - Holman
14 - Mackenzie Bay
15 - Komakuk
16 - Pribilof Islands
17 - Sireniki
18 - St. Matthew Island

Figure 3-9. World bowhead whale distribution
(Source: Moore and Reeves (1993) after Braham et al. (1984))

Bowhead whales occur in seasonally ice-covered seas, generally remaining close to the pack-ice edge. The Bering-Chukchi-Beaufort Seas stock was severely reduced by commercial Yankee whaling between 1848 and 1915 and remains by far the single biggest impact and source of mortality to this population from which it is still recovering nearly a century later (Bockstoce et al. 2005, George et al. 2004). Throughout the winter, bowhead whales frequent the marginal ice zone and polynyas in the western and central Bering Sea (Braham et al. 1984). Moore et al. (2000) determined that bowhead whales select deeper continental shelf areas (660 to 6,560 feet) with moderate to light ice conditions during summer (July and August). In the last decade, acoustic surveillance has indicated some bowheads overwinter in the Northeast Chukchi Sea Polynya (Moore et al. 2006, Roth, E., personal communication). In autumn (September through October), bowhead whales are associated with shallower outer and inner shelf areas (less than 660 feet) and light ice conditions (Moore et al. 2000). The Bering-Chukchi-Beaufort Seas stock of bowhead whales are distributed in summer in a broad area from Amundsen Gulf and the Eastern Beaufort Sea to the eastern part of the East Siberian Sea and into the northern Bering Sea.

Migration

As a general rule, bowhead whales migrate through the Beaufort Sea offshore of the planning area while traveling between wintering areas in the Bering Sea and summer feeding grounds in the Canadian Beaufort Sea, although some animals may remain in areas offshore in the Beaufort and Chukchi seas throughout the summer. The spring migration typically begins in the Bering Sea in mid-March to early April, depending on ice conditions. During the spring migration, bowhead whales follow somewhat predictable leads that form along the coast of western Alaska to Point Barrow. From Point Barrow eastward to Amundsen Gulf, the leads and the migration occur farther from shore based largely on satellite telemetry tracks (Alaska Department of Fish and

Game, unpublished data[19]). From April to June, most bowhead whales are distributed along a migration corridor that extends from their Bering Sea wintering grounds to their feeding grounds in the eastern Beaufort Sea (Moore and Reeves 1993). Some bowhead whales migrate westward to feeding grounds in the western Chukchi Sea (Bogoslovskaya et al. 1982, Mel'nikov et al. 1997, Alaska Department of Fish and Game satellite telemetry data). Bowhead whales arrive on their primary summer feeding grounds in the eastern Beaufort Sea from mid-May through June and remain in the Canadian Beaufort Sea and Amundsen Gulf until late August or early September. Some whales may occur regularly in the western Beaufort Sea, particularly near Barrow Canyon, and in the Chukchi Sea along the northwestern Alaskan coast in late summer. These animals may be summer residents but may also be "early autumn" migrants. However, it should be noted that recent telemetry data has suggested that bowhead movements are far more labile within their range than formerly thought (Quakenbush et al. 2010) and 'reverse' migratory behavior has been documented.

During the spring migration, Bering-Chukchi-Beaufort Seas bowhead whales migrate in pulses composed of aggregations of individuals (Ljungblad et al. 1986, George et al. 2004, Carroll and Smithhisler 1980). Iñupiat traditional knowledge (summarized in Braham et al. 1980) holds that the pulses are segregated by age and sex; the first two pulses are generally subadults and adults without calves, while cows with calves do not typically arrive until the third and final pulse. This has been largely substantiated with acoustic data and visual surveillance (George et al. 2004, Koski et al. 2008). The first migrants are usually seen near Point Barrow in mid-April, but may arrive later in heavy ice years (Krogman et al. 1989). After passing Point Barrow, most of the bowheads travel east through offshore leads in the continuous pack ice to feeding grounds in the eastern Beaufort Sea (Richardson and Thomson 2002).

Bowhead whales that have summered in the eastern (Canadian) Beaufort Sea begin the fall migration in late August to September and are usually out of the Beaufort Sea by late October (Treacy 1988–1997, 2000, 2002a, 2000b; Moore and Reeves 1993). The fall migration route extends from the eastern Beaufort Sea, along the continental shelf across the Chukchi Sea, and down the coast of the Chukotka Peninsula (Moore and Reeves 1993, Quakenbush et al. 2010b)

The extent of ice cover may influence the route, timing, or duration of the fall migration. Moore et al. (2000) noted that bowheads in the U.S. Beaufort Sea tended to be distributed closer to shore during their westward migration in light ice years. Miller et al. (1996) also observed that whales moving from 147° to 150° West longitude in the central Beaufort Sea, migrated closer to shore in light and moderate ice years (median distance offshore 18 to 25 miles), and farther offshore in heavy ice years (median distance offshore 35 to 45 miles).

Foraging

Bowhead whales are filter feeders that feed throughout the water column, including bottom or near-bottom, mid-column, and at the surface, where they skim feed (Würsig et al. 1985). Carbon-isotope analysis of bowhead whale baleen suggests that bowhead whales obtain significant proportions of their food in both summering and wintering areas (Schell et al. 1987, Schell and Saupe 1993, Sheffield et al. 2008).

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[19] http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.bowhead

Subsistence whalers from Saint Lawrence Island have reported bowhead whales commonly seen milling in the spring, a behavior associated with feeding (Wursig et al. 1985) and reports of food in stomachs are not unusual (Hazard and Lowry 1984, Sheffield et al. 2008). Additional traditional knowledge of Siberian Yupik whalers on Saint Lawrence Island indicates that bowhead whales regularly exhibit feeding behavior near the island during both the spring and fall seasons (Noongwook et al. 2007). Sheffield et al. (2008) confirmed direct evidence, via stomach contents and fecal analysis, of bowheads feeding near Saint Lawrence Island in late November as well as early spring.

Bowhead whales feed opportunistically where food is available as they migrate through the Alaskan Beaufort Sea sometimes close to shore (Lowry et al. 2004, Richardson and Thomson 2002, Treacy 2002b, Moore et al. 2010). Examination of stomach contents from whales taken in the Iñupiat subsistence harvest indicates that bowhead whales feed on a variety of invertebrates and small fishes and that the Beaufort Sea includes several important feeding areas (Lowry 1993, Lowry et al. 2004). Food items most commonly found in the stomachs of harvested bowhead whales include euphausiids, copepods, mysids, and amphipods (Moore et al. 2010, Lowry et al. 2004). Euphausiids and copepods are thought to be their primary prey. Zooplankton sampling near bowheads feeding in Camden Bay during fall migrations found they associated with dense swarms of euphausiids (*T. raschii*) or copepods (*Pseudocalanus* spp.) (Moore et al. 2000). Stomach analysis from whales harvested at Barrow found that 73 percent of the whales taken in autumn were feeding while only 31 percent of the whales taken in spring were feeding. Whales taken at Cross Island and at Kaktovik during autumn also showed high rates of feeding (Lowry et al. 2004). A higher proportion of photographed individuals also show evidence of feeding in fall than in spring (Mocklin 2009).

Bowhead whale known and suspected feeding areas, based on visual observations and tagging data, include Amundsen Gulf, near Barrow, the area surrounding Wrangel Island, the northern coast of Chukotka, the western Bering Sea, and near Kaktovik and Camden Bay (Clarke et al. 2011a, b, c; Koski and Miller 2009, Quakenbush et al. 2010a). Bowhead whales were also observed feeding in the vicinity of Peard Bay and Pt. Franklin during summer 2009 (Clarke et al. 2011a).

Regular, recurring feeding and high density prey areas in the Alaskan Arctic had not been identified until recently. The nearshore area east-southeast of Point Barrow appears to be one of the more important feeding areas in the U.S. Beaufort (Ashjian et al. 2010, Moore et al. 2010, Clarke et al. 2011b). A bowhead whale feeding "hotspot" (Okkonen et al. 2011) commonly forms on the western Beaufort Sea shelf off Point Barrow in late summer and fall. Moore et al. (2010) and Ashjian et al. (2010) suggest that physical forcing concentrates euphausiids in the areas east of Point Barrow. Distribution of apex consumers like bowheads is typically associated with areas of high prey productivity and density (Ainley and DeMaster 1990). High-density areas of bowheads may therefore indicate areas important to bowhead for foraging.

Survival and Mortality

Bowhead whales are a long-lived species, with examples of individuals greater than 100 and possibly up to 200 years old (George et al. 1999). Commercial and, to a far less extent subsistence whaling, have been the greatest causes of bowhead whale mortality for the last several centuries. Currently, the Alaskan Eskimo Whaling Commission is allowed 67 strikes per year, which, if all were fatal, would result in 0.5 percent mortality of the stock from subsistence activity and applying the most current abundance estimate. Hunters in some communities preferentially hunt immature whales (Philo et al. 1993b, Suydam and George 2004). Zeh et al. (2002) estimated natural mortality at 1 to 2 percent based on more direct evidence using photo-recapture analysis; this is considered more robust than earlier estimates by Breiwick et al. (1984). Bowhead whales have no known predators except killer whales. Attacks by killer whales have occurred, but the frequency is probably low. Likewise, the scarcity of observations of vessel-inflicted injuries suggests that the incidence of ship collisions with bowhead whales is also low (George et al. 1994). Some whales die as a result of line entanglement and as a result of entrapment in ice, but the number is thought to be relatively small (Philo et al. 1993b, Reeves et al. 2012). Little is known about mortality rates from microbial or viral pathogens (Philo et al. 1993).

Bowheads likely mate in late winter or early spring, although mating behavior has been observed at other times of the year (Nerini et al. 1984). They typically calve in April through early June after a 13 to 14 month gestation period (Nerini et al. 1984, Koski et al. 1993), and give birth in ice leads during the spring migration through the Bering and Chukchi seas. Pregnant bowheads harvested at Barrow during spring also indicate that some portion of the population is calving in the Beaufort Sea (Suydam and George 2004), although the location of those calving areas is unknown.

Sensory Systems

Bowhead whales likely hear in low frequency ranges, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Inferring from their vocalizations, bowhead whales should be most sensitive to frequencies between 20 Hz-5 kHz, with maximum sensitivity between 100-500 Hz (Erbe 2002). Subsistence hunters also note that bowhead whales are sensitive to noise during the spring whaling season (Noongwook et al. 2007).

Olfaction may also be important to bowhead whales. Recent research on the olfactory bulb and olfactory receptor genes suggest that bowheads not only have a sense of smell but one better developed than in humans (Thewissen et al. 2011). The authors suggest that bowheads may use their sense of smell to find dense prey aggregations.

Bowheads in NPR-A Coastal Waters

In most years, nearly the entire Bering-Chukchi-Beaufort Seas bowhead whale population traverses the NPR-A coast during the spring and fall migrations, although they usually travel several to tens of kilometers offshore. During the Bureau of Ocean Energy Management's annual Bowhead Whale Aerial Survey Project (BWASP) conducted in the autumn in the Beaufort Sea from 1987 to 2010, many bowhead whale sightings were made in the western Beaufort Sea within a few kilometers of shore from Point Barrow to Cape Halkett (Treacy 2002, Clarke et al. 2011b). With increased survey effort since 2005 and the initiation of the Bowhead Whale Feeding Ecology-Study (BOWFEST) in 2007, groups are regularly seen feeding or milling from Point Barrow to Cape Simpson and the mouth of Dease Inlet (Treacy 2002, Clark et al. 2011b, National Marine Mammal Laboratory 2009, 2010). Large feeding aggregations were seen in this area in 1992 (Treacy 1993) and subsequent years (2005–2010) during BWASP and BOWFEST surveys. Bowheads and gray whales, sometimes in mixed groups, often frequent the nearshore area particularly following strong east wind events from Cape Halkett to Point Barrow and the northeast Chukchi Sea coast (Ashjian et al. 2010, Moore et al. 2010, Clark et al. 2010, National Marine Mammal Laboratory 2010)

In contrast, during the spring migration, the nearshore waters of the Beaufort are completely ice covered with shorefast ice and the migration occurs far from the Beaufort Sea coast (Braham et al. 1980). However, they typically migrate within a few kilometers of the shorefast ice edge during the spring migration particularly at the cape headlands such as Lisburne, Icy Cape, Cape Franklin, and Point Barrow (Moore and Reeves 1993). In fall, bowhead whales occur along the Chukchi coast but typically in small numbers near Point Barrow and Point Franklin (Clark et al. 2011a, Moore and Reeves 1993); however, with increasing population size this may become more common as was apparently the case during the Yankee Whaling period based on kill locations (Bockstoce et al. 2005).

Humpback Whale

The humpback whale (*Megaptera novaeangliae*) is classified as endangered under the ESA and as depleted under the Marine Mammals Protection Act. Humpback whales range throughout the world's oceans, with lower frequency use of Arctic waters (Perry et al. 1999, Allen and Angliss, 2010). The Bering Straits are considered to be the northern limit of the humpback's range (Angliss and Outlaw 2005) although there is some evidence that they at least historically used the southern Chukchi Sea. Sightings in the Beaufort Sea are rare. A humpback mother-calf pair was noted in the Beaufort Sea east of Barrow in August 2007 (Hashagen et al. 2009). It is not known if that sighting was a rare extralimital movement or a northward shift in range. Humpbacks have not been observed during the Bowhead Whale Aerial Survey Project surveys or reported in the Beaufort Sea previously. Ireland et al. (2008) reported three humpback sightings in 2007 and one in 2008 during surveys of the eastern Chukchi Sea and a single humpback whale was seen on 25 July 2009 at 70.384° N, 160.837° W, in survey Block 17 of the COMIDA surveys of the northeastern Chukchi Sea. The whale was feeding very near shore and close to four gray whales (Clarke et al. 2011a). Regardless there is little information on humpback whale foraging, movements, or habitat use in the Beaufort or Chukchi seas.

Humpback whales observed in the Beaufort and Chukchi seas are either from the central or western Pacific stock. No reliable information is available to estimate population size of either stock in Alaska but the North Pacific population (including the western and central Pacific stocks) is estimated at 19,594 (Calambokidis et al. 2008). There is no information about how many humpbacks occur in the northeast Chukchi and Beaufort seas but the number is likely low based on recent surveys (Clarke et al. 2011a).

North Pacific humpbacks undergo a winter migration to tropical and temperate areas to calve and mate before returning to northern waters to feed in the summer (Perry et al.

1999). The western and central Pacific stocks appear to overlap while foraging in the Gulf of Alaska and possibly the Bering Sea (Allen and Angliss 2011).

Humpback whales are lunge-feeders that engulf large volumes of water and then filter small crustaceans and fish through their fringed baleen plate. They are relatively generalized in their feeding and, in the North Pacific, primarily consume euphausiids (krill) and a variety of small schooling fish (Krieger and Wing 1986, Nemoto 1957 and 1959, Perry et al. 1999, Witteveen et al. 2008).

Humpback whales are in the low-frequency functional hearing group, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Humpback whales produce several sounds, including “songs” in the late fall, winter, and spring by solitary males, and social sounds on the wintering (calving) grounds and on the feeding grounds (Richardson et al. 1995). Vocalizations recorded on high latitude feeding grounds were in the 20 Hz to 2 kHz range, with source levels of 175 to 192 dB re 1 µPa-m (Richardson et al. 1995).

Fin Whale

The fin whale (*Balaenoptera physalus*) is listed as endangered under the ESA and as depleted under the Marine Mammals Protection Act They are distributed in all oceans (Allen and Angliss 2010, Macdonald 2001), but tend to occupy temperate and polar waters. Fin whales feed in northern latitudes during the summer where their prey include plankton, as well as shoaling pelagic fish, such as capelin (*Mallotus villosus*) (Jonsgård 1966). The Northeast Pacific fin whale stock’s summering grounds extend from the Chukchi Sea to California (Gambell 1985), but are not known to include the Alaskan Beaufort Sea or the northern Chukchi Sea.

There are currently no reliable estimates of abundance for the entire Northeast Pacific stock of fin whales. Surveys in the Bering Sea and coastal waters from southcentral Alaska to the central Aleutian Islands provide the only data from which estimates were derived. The estimate of 5,700 whales is considered a minimum for this stock, since surveys only covered a small part of the range (Allen and Angliss 2010). No estimates for fin whale abundance during the summer in the Chukchi Sea are available.

Occurrence in Alaskan waters in summer and fall has been documented primarily in the Gulf of Alaska and Bering Sea (Mizroch et al. 2009). Fin whales are rarely reported on visual surveys in the Arctic. Ireland (2008) reported fin whale calls in the Chukchi Sea during the industry joint monitoring program in 2006, which were confirmed with visual sightings (Reiser et al. 2009). One fin whale was observed north of Cape Lisburne during Chukchi Offshore Monitoring in Drilling Area aerial surveys in July 2008 (Clarke et al. 2011a). In 2008, there were two sightings of four fin whales recorded by marine mammal observers during Chukchi Sea seismic surveys (Funk et al. 2010). Fin whales have not been reported in the Beaufort Sea. Fin whales have also been detected acoustically in the Chukchi Sea (Hannay et al. 2011). Fin whales appear to exit the Chukchi Sea before new ice forms in the fall. However, there are so few fin whales in the Chukchi Sea that the timing or route of their autumn exit from the Chukchi Sea has not been determined.

In general, fin whales in the North Pacific prey on euphausiids (krill) and large copepods, as well as schooling fish such as herring, walleye pollock, and capelin (Nemoto 1970, Kawamura 1982).

No studies have directly measured the sound sensitivity of fin whales. Fin whales are grouped among low frequency functional hearing baleen (mysticete) whales with an estimated auditory range of 7 Hz to 22 kHz (Southall et al. 2007). They most frequently vocalize at low frequencies of 15-30 Hz, with the loud, short calls (20 Hz pulses) most common (Frankel 2009, Moore et al. 1998, Watkins et al. 2000).

Polar Bear

Polar bears (*Ursus maritimus*) have circumpolar distribution in the northern hemisphere, with two populations occurring in Alaska—the Chukchi/Bering Sea population and the Southern Beaufort Sea population. The two populations overlap in the western Beaufort Sea and the eastern Chukchi Sea from Point Hope to Point Barrow, but they have been distinguished based upon information about contaminants and movement data from satellite collars (Amstrup et al. 2004, Amstrup et al. 2005).

The polar bear's principal habitat is the annual ice over the continental shelf and inter-island archipelagos that encircle the polar basin (Derocher et al. 2004). The coast, barrier islands, and shorefast ice edge provide an important corridor for polar bears traveling and feeding during fall, winter, and spring months. Late winter and spring leads that form offshore from the Chukchi Sea coast provide important feeding habitat for polar bears (see Map 3.3.8-6). Polar bears prey primarily on ringed seals and bearded seals; and they occasionally take walruses and beluga (Amstrup and DeMaster 1988). Polar bears will also feed opportunistically on a variety of foods, including carrion and bird eggs (Smith 1985, Smith and Hill 1996). During the autumn open water period, polar bears commonly swim ashore and scavenge beached carcasses or the remains of bowhead whales taken by subsistence hunters (Klaxdorff and Proffitt 2003). Recently in Alaska, relatively large numbers of polar bears have concentrated during autumn near the villages of Barrow and Kaktovik and near the Nuiqsut whaling camps on Cross Island (Miller et al. 2006).

The Beaufort Sea coastline, creek and river drainages, and bluffs along lakes throughout NPR-A provide important areas for polar bear resting, feeding, denning, and seasonal movements. In northern Alaska, pregnant polar bears enter maternity dens by late November and emerge as late as April. Maternity dens are located in snowdrifts in coastal areas, on stable parts of the offshore pack ice, or on landfast ice (Amstrup and Garner 1994). The U.S. Geological Survey recently summarized known polar bear maternal dens locations in the Beaufort Sea and neighboring regions (Durner et al. 2010); the location of polar bear dens occurring in the vicinity of NPR-A are shown on Map 3.3.8-6. Along the Alaska Chukchi Sea coast, polar bear denning occurs at Cape Lisburne, Cape Beaufort, the barrier islands between Point Lay and Peard Bay, the Kukpowruk, Kuk, and Sinaruruk rivers, Nokotlek Point, Point Belcher, Skull Cliff, and Wainright Inlet.

Both Southern Beaufort Sea and Chukchi/Bering Sea bears den on pack ice and on land. Fifty-three percent of the dens used by Southern Beaufort Sea bears, detected by radio-telemetry, were on pack ice, while 38 percent were on land (Amstrup and Gardner 1994). Terrestrial maternal dens were significantly less common within the Planning Area than along the coastal plain of the Arctic National Wildlife Refuge (Amstrup and Gardner 1994). Of 35 terrestrial dens on the Arctic Coastal Plain of northern Alaska in 2001, the majority (29) were found along coastal bluffs, with the remainder found on river/creek banks, lakeshores, and one at an abandoned drilling pad. All dens were within 15 miles of the coast (Durner et al. 2003). Southern Beaufort Sea bears appear to have fidelity to denning areas and substrate type but not to particular denning sites. In other words, females may return to general geographic areas, but not necessarily a specific previous maternal den (Amstrup and Gardner 1994). Average distance between subsequent dens was 181 miles. Therefore, historic dens may not be a good indicator of future den sites, but they do suggest that future denning should be expected in the general geographic area.

There has been an apparent shift in recent years to more terrestrial denning and fewer dens on pack ice, possibly due to changes in features of pack ice that reduce its suitability as denning habitat (Fischbach et al., unpublished data [cited in Regehr et al. 2006]). Numbers of polar bears on land during the summer open water period are also likely to continue to increase as sea ice extent continues to rapidly decrease due to climate change (discussed below).

Accurate population estimates for the Southern Beaufort Sea and Chukchi/Bering Sea polar bear populations are difficult to obtain because the species is widely distributed at low densities in fairly inaccessible habitat, and because of movement of bears across international borders (Amstrup and DeMaster 1988, Garner et al. 1992). Research on the Southern Beaufort Sea population began in 1967. This is one of only four polar bear populations with a long-term (greater than 20 years) data set. Recent assessments estimate the Chukchi/Bering Sea population is a minimum of 2,000 bears and the Southern Beaufort Sea population is a minimum of 1,397 bears, although there is uncertainty regarding both estimates (74 Federal Register 69139 [July 1, 2009]). Polar bears are long-lived animals but have a low reproduction rate because they mature late, have an extended breeding interval, and have small litters (Lentfer et al. 1980, Demaster and Stirling 1981, Amstrup 2003). Given a small population in a species with low reproductive rates, any loss of large numbers of polar bears (and especially adult females) or their prey species would exacerbate their low reproductive potential.

The polar bear was listed as threatened throughout its range due to loss of sea ice habitat caused by climate change (73 Federal Register 28212 [May 15, 2008]). The U.S. Fish and Wildlife Service concurrently published an Interim Final 4(d) Rule, which provides guidance on the implementation of the ESA. The Interim Final Rule adopts the existing conservation regulatory requirements in place under the Marine Mammal Protection Act and Conventional on International Trade in Endangered Species of Wild Fauna and Flora as the appropriate regulatory provisions for this threatened species.

Critical Habitat for polar bears was designated in 2010 (74 Federal Register 56058 [December 2, 2010]), identifying geographic areas containing habitat features that are essential for the conservation of the polar bear and that may require special management considerations. The U.S. Fish and Wildlife Service has identified three critical habitat areas or units including (1) barrier islands and spits along Alaska's coast, (2) sea ice habitat over the continental shelf (includes ice over water 300 meters and less in depth), and (3) terrestrial denning habitat on the northern coast of Alaska between the Canadian border and Barrow (within the NPR-A, this includes land within 5 miles [8 kilometers] of the coast). Terrestrial denning habitat was not designated along the U.S. Chukchi Sea coastline. In recent years, sea ice formation along the coastline is occurring later in the winter, which may preclude access to coastal denning areas along the U.S. Chukchi coastline.

Ringed Seal

Ringed seals (*Phoca hispida*) are the smallest and most abundant of the Arctic ice seals (seals that use ice to carry out important life history traits) (Smith and Hammill 1981, Kingsley 1986). Ringed seals have a circumpolar distribution, occurring in all areas of the Arctic Ocean north of approximately 35° north latitude (Kelly et al. 2010, King 1983). Five distinct subspecies are recognized (*P. h. hispida*, P. *h. ochotensis*, *P. h. botnica*, *P. h. ladogensis*, and *P. h. saimensis* (Kelly et al. 2010). Currently, ringed seals are listed as one stock in Alaska based solely on distributional data. A reliable population estimate for the Alaska stock (*P. h. hispida*) is currently unavailable, but a minimum abundance estimate of 249,000 ringed seals is estimated for the Beaufort and Chukchi seas adjacent to the NPR-A based on surveys conducted by Bengtson et al. (2005) and Frost et al. (2002) (Allen and Angliss 2009). Kelly et al. (2010) estimated that the total population of ringed seals in the Beaufort and Chukchi seas could number approximately 1 million. This extrapolation was based on surveys conducted by Frost et al. (2004) and Bengston et al. (2005) within 40 km of the coast which produced a minimum population estimate of 300,000, and by accounting for seals in the pack ice outside of the survey areas and those found in the eastern Beaufort and Amundson Gulf (Allen and Angliss 2012). A possible decline of 31 percent between the 1980s and the 1990s was detected by Frost et al. (2002)This may have been an artifact of survey timing, but could also be attributed to increased competition for prey resources or increased predation. Yearly use areas of individual seals can be quite extensive with discreet home ranges being important on a seasonal basis. Recent research shows satellite tagged animals ranging from the southern edge of the seasonal ice pack in the Bearing Sea to north of point Barrow in a single year (Frost, K., personal communication, 2010). [20]

Area-specific densities of ringed seals in waters adjacent to the NPR-A may depend on a number of factors including ice conditions, food availability, water depth, seal life history traits, and human disturbance. Although ringed seals do not occur in large herds, loose aggregations of tens or hundreds of animals do occur, probably in association with abundant prey. Ringed seals can commonly be found in the shorefast ice region of the planning area from January to June with breathing holes being maintained within a couple of hundred meters of the shoreline. During the shorefast ice period, home range sizes for individual seals are small with maximum known travel distances of 54 kilometers by tagged seals (Kelly et al. 2008). Home range size shrinks even further during pupping and molt (March to June) to an average of 2 square kilometers (Kelly 1988, Kelly et al. 2008). The most recent density estimates of ringed seals during molt range from 0.51 to 1.19 seals per square kilometer (Frost et al. 2002) in the Beaufort Sea and 1.62 to 1.91 seals per square kilometer in the Chukchi Sea (Bengtson et al. 2005).

Subnivean (under snow) lairs built over breathing holes in snowdrifts and pressure ridges in the sea ice are crucial to the recruitment, success, and survival of ringed seals. Both adult males and females appear to establish and defend territories around these lairs, thus accounting for decreased home range size. These lairs provide protection from predators and thermoregulatory protection for newborn pups (Stirling and Smith 2004). Pups are born with a white lanugo coat that is shed within 4 to 6 weeks of birth, by which time they have developed sufficient blubber layers for insulation before weaning (Kelly 1988). Pupping is thought to occur in March and April, followed by mating in March to May, and molt in May through June (Kelly 1988). Individuals return to specific areas year after year, building and maintaining their subnivian structures around which these important life history traits are carried out (Smith and Hammill 1981, Kelly et al. 2008).

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[20] http://kotzebueira.org/current_projects2.html

Ringed seals are thought to be primarily pelagic foragers. Their diet varies significantly by season, age, and location. Arctic (*Boreogadus saida*) and saffron (*Eleginus gracilis*) cods, hyperiid amphipods (*Parathemisto libellula*), euphausiids (*Thysanoessa* spp.) and some shrimps appear to be the most important prey items by quantity consumed and prey energy content (Lowry et al. 1980). During the spring-summer period, hyperiid amphipods are the most important food source in the central Beaufort Sea and euphausiids are important in the boundary region (Barrow area) between the Chukchi and Beaufort seas. During late summer-early autumn, hyperiid amphipods are important foods in the central Beaufort and the southeastern Chukchi. Arctic and saffron cod are more important to adult seals and become the most important prey source for all age classes in both the Beaufort and Chukchi seas during the autumn and winter (Lowry et al. 1980, Dehn et al. 2007).

Ringed seal harvest continues to be important to communities within the planning area, and, thus, an important source of mortality. Ringed seal harvest is most active during spring, but occurs occasionally throughout the summer and fall (Bacon et al. 2009, Braund 2010). Refer to Section 3.4.3 ("Subsistence") for further discussion of ringed seal harvests.

In 2011, over 60 dead and 75 diseased mostly ringed seals were reported in the Arctic and Bering Straits regions of Alaska (NOAA 2011). Characteristics of the disease include hair loss, skin sores on the hind flippers and face, and, for some, labored breathing and lethargy. In December 2011, NOAA declared the deaths an unusual mortality event (NOAA 2011). In February, a young seal originally thought to be a ringed seal was found in Yakutat sick with symptoms consistent with this disease (NOAA 2012a). Results of DNA analyses subsequently determined this was a young ribbon seal that was misidentified due to excessive hair loss (Robert Suydam, North Slope Borough Department of Wildlife Management, personal communication). In 2012, Native subsistence hunters documented over 40 seals with clinical signs of the disease (NOAA 2012b).

The underlying cause is still unknown. Despite numerous tests for viral, bacterial pathogens, and biotoxins, no specific disease agent or process has been identified. The following have been ruled out, so far: Phocine distemper, influenza, Leptospirosis, Calicivirus, orthopoxvirus, and poxvirus, foot and mouth disease, VES, pan picornavirus, and Rickettsial agents (NOAA 2012a, 2012b). Tissue samples were also collected to analyze heavy metals, radionuclides (radiation), and persistent organic pollutant levels (NOAA 2012b). Results are pending, although preliminary screening showed radiation levels within the typical background range for Alaska and not of a level that would cause the observed symptoms (NOAA 2012c).

As of December 2010, ringed seals have been proposed for listing under the ESA by the National Marine Fisheries Service. The major reason cited for the proposed listing of this species is the projected loss of sea ice habitat and associated snow cover for subnivean maternal dens. No critical habitat is proposed for designation at this time as it is currently undeterminable (USDOC NOAA 2010b).

Bearded Seal

Bearded seals (*Erignathus barbatus nauticaus*) are a pagophilic (ice-associated) seal present in the Chukchi and Beaufort seas year round. They are generally considered to inhabit areas of shallow water (less than 200 meters) that are at least seasonally ice covered (Burns 1970, Kelly 1988b, Cameron et al. 2010). Currently only a single stock is recognized for Alaska based solely on distributional data (Allen and Angliss 2009). Abundance estimates of bearded seals in Alaska waters are currently unavailable (Allen and Angliss 2009). Early estimates of the Bering-Chukchi Sea population range from 250,000 to 300,000 (Kelly 1988b).

Bearded seals are widely distributed across the waters adjacent to the NPR-A, with highest concentrations occurring over the continental shelf. Bearded seals often congregate in favorable areas, but are not known to form herds (Burns 1970). They are most commonly found in the offshore pack ice near flaw-zones and leads (Burns 1967, Bengtson et al. 2005, Allen and Angliss 2009). It is thought that the population in Alaskan waters is largely migratory. Individual use areas can be quite large with recent research showing adult bearded seals traveling from Kotzebue Sound, Alaska, in the southern portion of the Chukchi Sea to the U.S./Canadian border in the Beaufort Sea (Boveng, P., National Marine Mammal Laboratory, personal communication, 2010). [21] Juveniles have been noted travelling from the southern edge of the ice pack in the Bering Sea to Point Hope, Alaska (Frost, K., University of Alaska Fairbanks, personal communication, 2010). [22] This research also suggests that individuals may maintain discreet seasonal home ranges.

Bearded seals are generally considered benthic (bottom-dwelling) generalist foragers, consuming prey items that may vary with location, age-class, and season. Major species of consumption in waters near the NPR-A include clams, shrimp, octopus, echiurid worms, and arctic cod (Boreogadus saida) (Lowry et al. 1980, Kelly 1988b, Dehn et al. 2007). The most pronounced age specific difference in diet observed has been the consumption of more clams by adults with juveniles consuming more shrimp (Lowry et al. 1980b).

Bearded seals are considered an ice obligate species that use this ice substrate for pupping and molting. Pups are born on the ice with most arriving between April 15–20, and some born as early as April 5 and some as late as May 3. Pups often or completely molt their lanugo coat while in utero and are born with a layer of subcutaneous fat (Kovacs et al. 1996). The first molt is otherwise completed before weaning at 12 to 18 days. The lanugo layer is thought to be important for insulation while pups are forming a thick blubber layer (Burns 1967). Pups enter the water within a few days of birth (Burns 1970) and start actively foraging soon after weaning. Mating takes place in April and May after the weaning of pups, followed by molt in May and June (Burns 1981, Kelly 1988b). Very little is known about the social behavior and exact molt cycle of these animals. Interstingly, bearded seals have been noted in the riverine systems of the NPRA during the late summer and fall and have been observed hauling out on coastal beaches and barrier islands (J. Herreman, North Slope Borough Department of Wildlife Management, personal communication)

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[21] http://kotzebueira.org/current_projects3.html

[22] http://kotzebueira.org/current_projects.html

Bearded seals are an important subsistence species for communities in the planning area. Many users prefer bearded seals for consumption over any other type of ice seal. Blubber is rendered into seal oil and the meat is cooked or dried for consumption. Bearded seals are the second most harvested seal in NPR-A communities after ringed seals(Bacon et al. 2009, Braund et al. 2010). Refer to Section 3.4.3 ("Subsistence") for further discussion of bearded seal harvests.

E. b. nauticus was proposed for listing as threatened under the Endangered Species Act by the National Marine Fisheries Service in December 2010. The major reasons cited for listing were the significant threats associated with habitat modification or loss due to current and projected reductions in sea-ice. This includes loss of nursing, pup-rearing, and molting habitat; spatial separation of sea-ice resting areas and benthic feeding habitats; and potential decreases in prey availability or density due to changes in sea ice cover and ocean temperature (Cameron et al. 2010, USDOC NOAA 2010a). No critical habitat is proposed for designation at this time as it is currently undeterminable (USDOC NOAA 2010a).

Pacific Walrus

The Pacific walrus (*Odobenus rosmarus divergens*) is a large pinniped that ranges throughout the shallow continental shelf waters of Bering and Chukchi Seas of Russia and Alaska, with their distribution closely linked to the seasonal location of the pack ice. Walrus are migratory, moving south toward the Bering Sea with the advancing ice edge in autumn, and north as the ice recedes in the spring (Fay 1981). During the summer months, the majority of subadults, females, and calves move into the Chukchi Sea where they tend to concentrate in areas of unconsolidated pack ice within 100 kilometers of the leading edge of the pack ice.

By July, large groups of up to several thousand walrus can be found along the edge of the pack ice offshore of NPR-A between Icy Cape and Point Barrow. During that time of year walrus can also be found in low numbers in the Beaufort Sea. Walrus rely on sea ice as substrate for resting and giving birth (Angliss and Outlaw 2005). They generally require sea ice of at least 50 centimeters thick to support their weight (Fay 1982). When suitable pack ice is not available, walrus will haul-out on land, preferring sites sheltered from wind and surf. Haul-out sites in the NPR-A have included the barrier islands off Kasegaluk Lagoon and Icy Cape, and shoreline areas near Wainwright and Peard Bay (Map 3.3.8-7).

Walrus are generally found along the pack ice margin, where ice concentrations are less than 80 percent. They feed primarily on clams and other invertebrates found on the seafloor; and, although capable of diving to greater depths, walrus usually feed in waters less than 80 meters deep over the continental shelf, where their prey is more abundant and easier to obtain (Fay 1982, Fay and Burns 1988, Jay et al. 2001). Walrus rest between feeding trips on sea ice or land. Sea ice provides walrus with a resting platform, access to offshore feeding areas, and seclusion from humans and predators.

The shallow Chukchi Sea and eastern Siberian Sea serve as the main feeding grounds for most of the Pacific walrus population in the summer and autumn (Kochnev 2004). The constant motion of the sea ice transports resting walruses over widely dispersed prey patches (Fay 1974). Walruses can have a large effect on their prey feeding areas and play an important role in the Arctic ecosystem by influencing the structure of benthic communities. They eat large quantities of clams daily (Fay 1985, Born et al. 2003), and as they root along the sea floor in search of food, they plow through large quantities of sediment (Nelson and Johnson 1987, Nelson et al. 1994). Those activities remove large quantities of prey from the seafloor, affect the size of clam populations, mix bottom sediments, create new microhabitats from discarded shells, and generate food for seafloor scavengers from uneaten scraps of prey (Oliver et al. 1983).

The juxtaposition of broken ice over relatively shallow continental shelf waters is important for walrus as a place to rest between feeding bouts, particularly for females with dependent young that may not be capable of deep diving or long term exposure to frigid water. Walrus calves are capable of swimming shortly after birth but tend to haul-out frequently until their swimming ability and blubber layer are well developed. Cows brood neonates to aid in their thermoregulation, carrying them on their backs or under their flipper while in the water. Females with newborns often join together and form nursery herds. Walruses are very social and gregarious animals. They tend to travel in groups and haul-out on ice or land in groups. Walruses spend about one-third of their time hauled-out on ice or land. When hauled out, walrus tend to lie in close physical contact with each other; and youngsters often lie on top of adults.

Disturbance events can cause walruses to stampede into the water and have been known to result in injuries and mortalities, and the risk of stampede-related injuries increases with the number of animals hauled out (Ovsyanikov 1994). Calves and young animals at the perimeter of these herds are particularly vulnerable, and trampling-related injuries and mortalities have been reported at coastal walrus haul-outs used by adult females and young (Fay and Kelly 1980, Ovsyanikov 1994, Kavry et al. 2008).

The size of the Pacific walrus population has never been known with certainty, and a 2006 survey estimated a minimum population size of 129,000 (74 *Federal Register* 69139, Speckman et al. 2011). Some researchers believe the population may be in decline based upon age structure and productivity information (Garlich-Miller et al. 2006). There is concern the Pacific walrus has undergone a population decline from the estimated pre-exploitation population of approximately 200,000 Pacific walrus in the 1970s and 1980s (Fay 1982).

Walrus have been hunted by coastal Natives in Alaska and Chukotka, Russia for thousands of years. Exploitation of the walrus by Europeans has also occurred in varying degrees since first contact. Presently, walrus hunting in Alaska and Chukotka is restricted to meet the subsistence needs of aboriginal peoples. Over the past decade, the combined harvest of the United States and Russia has averaged approximately 5,500 walruses per year, including corrections for under-reported harvest and struck and lost animals (73 *Federal Register* 33212 [June 11, 2008]).

In 2011, the U.S. Fish and Wildlife Service completed a finding that concluded listing the Pacific walrus as an endangered or threatened species is warranted because the loss of sea ice will lead to a population decline that is a threat to the species in the foreseeable future (76 *Federal Register* 7634 [February 10, 2011]). However, listing the Pacific walrus is currently precluded by the need to address higher priority species nationwide; the U.S. Fish and Wildlife Service is scheduled to consider the walrus for listing in 2017.

Special Status Species Marine Mammals and Climate Change

Climate change has the potential to greatly affect arctic marine mammal species. Effects will vary by species and may include but are not limited to expansion or contraction of ranges, loss of critical habitat, intermingling of previously separate populations, reduced access to prey resources, and introduction of new competitors and diseases.

The greatest environmental change that marine mammals face is a decrease in sea ice concentration and extent (Wang and Overland 2009, Boveng et al. 2008, Boveng et al. 2009, Cameron et al. 2010, Kelly et al. 2010). Considerable reductions in sea ice are expected over the next decades (Wang and Overland 2009). While it remains unclear exactly how changes in ice concentration will affect each species, it is clear that effects (positive or negative) will occur. There is some evidence that ice-retreat has not harmed bowhead whales over the last 30 years as population size has increased (George et al. 2004, Koski et al. 2010) and body condition has remained high even in seasons with considerable ice retreat (George et al. 2005). Furthermore, new records have been recorded for humpback whales in the Beaufort Sea and fin whales have occurred more regularly in surveys in the Chukchi Sea in recent years (Hashagen et al. 2009, Clarke et al. 2011a). Under some scenarios, ringed seals have the greatest potential for negative effects through the loss of ice substrate for hauling out during critical energetic periods (such as denning and molt) and lower quality pupping areas through the loss of suitable habitat for lairs (USFWS 2008, Durner et al. 2009, Hunter et al. 2010, Kelly et al. 2010). Bearded seals are projected to face a loss of sea ice habitat used during energetically important periods (nursing, pupping, molting), increased distances between sea ice resting habitat and important foraging areas, causing animals to travel farther to forage, and potential changes in prey caused by climate change impacts on ocean temperature (Cameron et al. 2010; USFWS 2009).

Laidre et al. (2008) provides a quantitative assessment of the response of several Arctic marine mammals to climate change. Their assessment suggest that species with a narrow niche and specialized feeding, strong seasonal dependence on sea ice, and reliance on an ice platform for predation or predator avoidance are the most susceptible to climate change. They scored bowhead whales as moderately susceptible to climate change. Ringed and bearded seal scored among the least sensitive species primarily due to “large circumpolar distributions, large population sizes, and flexible habitat requirements.” However, Laidre et al. (2008) note that available evidence suggests that climate effects to arctic sea ice and species ecology will ultimately be significant for all species if the climate models are accurate. In any case, predictions of climate effects on marine mammals are tricky since many diverse factors ranging from emerging disease to direct anthropogenic losses due to, for instance, commercial fishing gear are foreseeable and can interact in unpredictable ways. Hence, while bowhead whales appear to have been fairly resilient to climate change effects over the past three decades, this may not always be the case and they could be negatively affected in the future.

Increased ocean acidification could lead to ecosystem-wide food web changes that affect special status marine mammals. Calcified marine organisms, such as bivalves, crustaceans, and other invertebrates with calcium carbonate shells or skeletons, are at risk with increasing acidification (Fabry et al. 2009). Marine mammals that prey directly on and are largely reliant upon calcifying invertebrates, such as walrus, could be more directly impacted. Experimental studies on effects of ocean acidification on Southern Ocean krill suggest that krill evolved a certain level of resistance to increased carbon dioxide levels, but they might be increasingly vulnerable at high carbon dioxide levels that were shown to inhibit embryonic development (Kawaguchi et al. 2011). Arctic species of krill may respond similarly. Marine mammal species that feed at higher trophic levels (e.g., on fish or other marine mammals) or have more diverse diets are less likely to experience direct effects of ocean acidification on prey, but may eventually be impacted through cascade effects though the food chain.

Polar bears depend on a sea ice-dominated ecosystem. Sea ice provides a platform for hunting and feeding, for seeking mates and breeding, for movement to terrestrial maternity denning areas and occasionally for maternity denning, for resting, and for long-distance movements. The sea ice ecosystem supports ringed seals, the primary prey for polar bears, and other marine mammals that are also part of their prey base. Sea ice is rapidly diminishing throughout the Arctic. Large seasonal declines in optimal polar bear habitat have occurred in the Southern Beaufort and Chukchi Seas since 1985, and it is predicted that the greatest declines in 21st century optimal polar bear habitat will occur in these areas (Durner et al. 2009).

The Chukchi and the Southern Beaufort Sea polar bear populations are currently experiencing negative effects from changes in sea ice conditions (Rode et al. 2010, Regehr et al. 2009, Hunter et al. 2010). These populations are known to be vulnerable to large-scale dramatic seasonal fluctuations in ice movements, which can cause decreased abundance and access to prey and increased energetic costs of hunting, leading to a decreased body condition (Regehr et al. 2010). The U.S. Fish and Wildlife Service and U.S. Geological Survey have predicted that, without changes in the rate of sea ice loss, the polar bear may be extirpated from much of their range in the next 40 to 75 years (73 *Federal Register* 28212 [May 15, 2008]), although Amstrup et al. (2010) also suggest that mitigating greenhouse gas emissions could reduce sea-ice loss and increase polar bear persistence.

Management and conservation concerns for the polar bear populations found within the planning area include human activities in the near shore environment, which contains habitats used by polar bears for denning, feeding, and seasonal movements (these habitats are important for the continued health of polar bear populations). Thinning ice and the greater extent of marginal ice stability in fall may be leading to reduced sea ice denning and a corresponding increase in denning on land (Fischbach et al. 2007). Additionally, the later formation of nearshore ice may increase bear use of coastal areas, which in turn increases the probability of disturbance to bears from human activities and the occurrence of bear-human interactions (Schliebe et al. 2006). In the last decade, the number of polar bears occurring along the coastal areas of the Beaufort Sea has been increasing (Amstrup 2000).

Because the Pacific walrus is an ice-dependent species, there are concerns that climate-change related sea ice loss will have numerous adverse effects on the species (76 *Federal Register* 7634 [February 10, 2011]). Changes in the extent, volume, and timing of the sea-ice melt and onset of freezing in the Bering and Chukchi Seas are projected to cause significant changes in the distribution and habitat-use patterns of walrus. With the loss of summer sea ice, a change already being observed is a greater dependence on terrestrial haulouts by both sexes and all age groups.

Historically, haulouts of tens of thousands of walrus have occasionally occurred on coasts in Chukotka (Kochnev 2006). Large onshore aggregations of walrus were unknown on the Alaskan side of the Chukchi Sea until 2007 (Fischbach et al. 2009) but have become a nearly regular occurrence since then. In recent years walrus have been observed hauling out in large numbers (hundreds to thousands) along the Chukchi Sea coast in late August through October, when there was no offshore sea ice in the vicinity. In September 2010, approximately 10,000 to 20,000 walrus congregated on a Kasegaluk Lagoon barrier island northwest of Point Lay (U.S. Geological Survey 2011).

Researchers documented 131 fresh carcasses of juvenile walrus in the vicinity of Icy Cape in September 2009 (Fischbach et al. 2009). Map 3.3.8-7 indicates the location of the walrus carcasses found in that mortality incident. The events that led to the deaths of the animals are unknown. Records indicate the eastern Chukchi Sea continental shelf was free of sea ice for more than 25 days prior to the discovery of the carcasses, and strong winds were recorded for the region in the weeks immediately prior to the discovery of the carcasses (Fischbach et al. 2009). In the absence of sea ice, strong winds result in heavy seas. Walruses cannot remain at sea indefinitely without rest. Telemetry data from walruses in ice-bearing waters of the northern Bering Sea revealed that walruses generally hauled out and rested every day or so, and that 98 percent of their in-water bouts lasted no longer than 7.5 days, with none exceeding 13 days (Udevitz et al. 2009).

In response to the recent summertime aggregations of walrus on the Alaskan Chukchi coastline, several conservation partners including the North Slope Borough, the Eskimo Walrus Commission, the Federal Aviation Authority, and the U.S. Fish and Wildlife Service have developed guidelines for pilots, marine vessels, and land-based viewing to discourage activities that could disturb walrus and cause them to stampede into the water (U.S. Fish and Wildlife Service News Release [September 14, 2010]). The guidelines are communicated to individuals in the communities closest to the haul-outs and others that use the area.

In addition to the potential for injury and mortality caused by stampeding in response to disturbance at terrestrial haulouts, other potential adverse consequences for walrus because of loss of sea ice and increased use of land include: increased energetic costs to reach prey, decreased body condition, calf abandonment due to disturbance or poor body condition, and increased exposure to predation and hunting.

The sharp decline in the extent of sea ice in recent years has resulted in less ice over the continental shelf of the Chukchi Sea during summer months (Meier et al. 2007, Stroeve et al. 2008). When sea ice recedes away from the shallow continental shelf, walrus must either stay with the sea ice as it retreats over deep water with little access to food, or abandon the sea ice and move to coastal areas where they can rest on land. Over time, walrus will be forced to rely on terrestrial haul-outs to a greater extent, exposing all individuals, but especially calves, juveniles, and females to increased levels of stress from depletion of prey, increased energetic costs to obtain prey, trampling injuries and mortalities, predation, and hunting.

The long-term ability of the prey base to support large numbers of walruses foraging from coastal haul-outs is unknown. The walrus' marine prey base itself is thought to be undergoing alterations due to climate change. Grebmeier et al. (2006) describes how the benthic productivity of the northern Bering Sea shelf is changing, undergoing a transition from an Arctic to a subarctic ecosystem, with a reduction in benthic prey populations that comprise the walrus prey base. Climate-change driven ocean acidification, as noted above, is also predicted to have adverse effects on the calcifying invertebrates (Ray et al. 2006, Sheffield and Grebmeier 2009) that form the basis of the walrus food chain.

3.3.9 Special Areas

3.3.9.1 Existing Special Areas

The NPRPA authorized the Secretary of the Interior to identify areas in the NPR-A "containing any significant subsistence, recreational, fish and wildlife, historical, or scenic value." Any exploration in these areas shall be conducted in a manner which will "assure the maximum protection of such surface values to the extent consistent with the requirements of the Act for exploration of the reserve" (42 USC § 6504). Federal regulations state that such values may be protected by limiting, restricting, or prohibiting the use of and access to appropriate lands in the NPR-A, including, but not limited to, rescheduling activities and use of alternative routes, types of vehicles and loading, limited types of aircraft in combination with minimum flight altitudes and distances from identified places, and special fuel handling procedures (43 CFR §§ 2361.1(c) and 2361.1(e)(1)). There are four Special Areas; their current boundaries are depicted on Map 3.3.9-1.

In 1977, the Secretary of the Interior designated three Special Areas within the NPR-A: the Teshekpuk Lake Special Area, the Colville River Special Area, and the Utukok River Uplands Special Area (*Federal Register*, June 3, 1977). The Teshekpuk Lake Special Area originally contained approximately 1.7 million acres. It includes important nesting, staging, and molting habitat for a large number of waterfowl and shorebirds and critical Teshekpuk Caribou Herd caribou calving, migration, and insect-relief habitat. It also includes the 211,000-acre Teshekpuk Lake, which is the dominant lake feature in the planning area. Consistent with a decision of the 1998 Record of Decision for the Northeast NPR-A IAP/EIS, roughly 10,000 acres encompassing the Pik Dunes were added to this Special Area (*Federal Register*, April 6, 1999). For more information on the importance of this area, especially for waterfowl and caribou, see the discussion of waterfowl and caribou in sections 3.3.5 and 3.3.6, respectively.

The Colville River Special Area as established in 1977 encompassed 2.3 million acres, including the bluff and riparian habitats of the Colville River, which are unique both biologically and geologically in the North Slope. This area has been recognized since the 1950s as one of the most significant regional habitats for raptors in North America (Kessel and Cade 1956 and 1958, Cade 1960, White and Cade 1971). The lower two-thirds of the Colville River support the highest concentrations of raptors, passerines, and moose on Alaska's North Slope. The raptors nest on bluffs adjacent to the river and are sensitive to disturbance. As a result of a decision made in the 1998 Northeast NPR-A Record of Decision, an area extending 2 miles on either side the Kikiakrorak and Kogosukruk rivers, two major tributaries of the Colville, as well as several southern tributaries of the Kogosukruk River, were added to the Colville River Special Area (*Federal Register*, April 6, 1999), enlarging it to approximately 2.44 million acres. For more information on the importance of this area for raptors, see section 3.3.5.7.

In designating the approximately 4-million-acre Utukok River Uplands Special Area in 1977, the Department of the Interior cited its importance for the Western Arctic Caribou Herd. A year before the designation, the population of the herd stood at 75,000 animals. (*Federal Register*, June 3, 1977) The area encompasses much of the herd's calving area and is also used during the insect-relief period after calving. For more information on the importance of this area, particularly for the Western Arctic Herd, see section 3.3.6.1.

The 2004 Record of Decision for the Northwest NPR-A plan created the approximately 97,000-acre Kasegaluk Lagoon Special Area. The Special Area encompasses the lagoon, its barrier islands, and an area 1 mile inland from the shore of the lagoon within NPR-A. The record of decision (page 20) stated that, "The Kasegaluk Lagoon Special area is being designated primarily because of high values for marine mammals. It also is a unique ecosystem for the arctic coast." The record of decision (page 4) also stated that, "The Kasegaluk Lagoon . . . offers primitive recreation experiences, including kayak and small boat paddling along the coast. It is also rich in wildlife, including migratory birds and marine mammals, and features marine tidal flats that are rare on the North Slope." A notification of the creation of the Kasegaluk Lagoon Special Area appeared in the *Federal Register* on February 24, 2005. For more information on the importance of the area for birds, marine mammals, and recreation, see sections 3.3.5, 3.3.7, 3.3.8, and 3.4.6.

3.3.9.2 Special Areas and Climate Change

Climate change may cause changes in the resources for which the Special Areas have been designated. See sections 3.3.5 through 3.3.8 for discussions on how these resources may be affected by a changing environment.

3.4 Social Systems

3.4.1 Land Ownership and Uses

This section describes the general ownership and uses of lands (surface, subsurface, and submerged estates) and waters in the NPR-A. This section will cover land ownership by the various governments and private parties, and a summary of BLM authorizations for a variety of activities and general public access to and from BLM-managed lands in the NPR-A.

3.4.1.1 Land Ownership

The largely unsurveyed legal description for the exterior boundary of the NPR-A has undergone a continuous refinement and interpretation process in order to obtain a more accurate definition based upon the original language in Executive Order 3797-A, numerous court decisions and subsequent agreements, and a decision issued by the Secretary of the Interior.

The exterior boundary of the NPR-A is described: "[t]he coastal boundary . . . is a continuous line . . . that begins at the western bank of the Colville River and follows the highest highwater mark westerly, extending across the entrances of small lagoons, including Peard Bay, Wainwright Inlet, the Kuk River, Kugura [sic] Bay and River, and other small bays and river estuaries, and following the ocean side of barrier islands and sand spits within 3 miles of shore and the ocean side of the Plover Islands, to the northwestern extremity of Icy Cape, approximately 70° 21' N., 161° 46' W." (*State of Alaska v. United States of America*, No. 84, Original, [June 2000], page 6a); "thence extending in a true south course to the crest of the range of mountains forming the watershed between the Noatak River and its northern tributaries and the streams flowing into the Arctic Ocean; thence eastward along the crest of this range of mountains" (Executive Order 3797-A) adjoined to the northern exterior boundary of the Noatak National Preserve to "approximately lat. 68° 04' N., long. 156° 00' W." (Interior 1986; *State of Alaska v. United States of America*, [D. Alaska 1986]); "thence in a true north course" (Executive Order 3797-A) along longitude 156° 00' West (Interior 1986; *State of Alaska v. United States of America*, [D. Alaska, 1986]) "to a point at the highest highwater" (Executive Order 3797-A) "of the western or left bank of the Colville River" (*State of Alaska v. United States of America*, [D. Alaska 1984]; "thence following said highest highwater mark downstream along said Colville River and the western bank of the most western slough at its mouth to the highest highwater mark on the Arctic coast" (Executive Order 3797-A).

Land ownership continues to change inside the exterior boundary of the NPR-A as the federal government works toward meeting its commitment to convey lands per the Alaska Native Claims Settlement Act (1971), as amended. To date, with an approximate 23,229,000 acres inside the exterior boundary of the NPR-A, approximately 95 percent remains as BLM-managed surface estate and approximately 98 percent BLM-managed subsurface estate. Native corporations own approximately 4 percent of lands in the NPR-A, the North Slope Borough owns less than 1 percent, and Native Allotments comprise approximately 0.13 percent. Because of land surface and mineral ownership overlaps and administrative responsibility overlaps, acreage figures for different jurisdictions do not add up to the total acreage. Table 3-21 summarizes land and mineral ownership in the NPR-A.

Table 3-21. Land and mineral ownership and administrative jurisdictions in the NPR-A

Ownerships and jurisdictions	Acres
Federally managed in part or whole	22,769,000
Federal surface estate and federal subsurface estate[1]	22,522,000
a. Native-selected	18,000
Non-federal surface estate with federal subsurface estate	247,000
a. Native corporation surface estate	215,450
b. Native allotments[2]	30,100
c. State of Alaska surface	1,450
Lands without any federal jurisdiction[3]	460,000
Total lands within exterior NPR-A boundary	23,229,000

1. About 428,000 acres are under major coastal bays, lagoons, and inlets.
2. Certificates of allotments issued on lands valuable for oil and gas contain a reservation of those minerals to the U.S. It is presumed that all certificates for allotments in the NPR-A contain this reservation.
3. The large majority of the lands without any federal jurisdiction are comprised of lands in which village corporations have been conveyed the surface and Arctic Slope Regional Corporation has received title to the subsurface estate.

Federal Jurisdiction

President Warren G. Harding established the Naval Petroleum Reserve Number 4 (PET-4) by Executive Order 3797-A in 1923, to reserve the lands for oil and gas development for

Naval defense purposes. The Naval Petroleum Reserves Production Act (NPRPA) of 1976 (Public Law 94-258) transferred jurisdiction of PET-4 from the Navy to the Secretary of the Interior and renamed it the National Petroleum Reserve in Alaska (NPR-A).

The NPR-A encompasses over 23 million acres, of which nearly 22.8 million acres are under federal jurisdiction. All surface waters are under federal jurisdiction unless expressly conveyed. Submerged lands and tidally influenced waters managed by the BLM within the NPR-A boundary include such salt waterbodies as Kasegaluk Lagoon, Wainwright Inlet, the Kuk River, Peard Bay, Kugrua Bay, Elson Lagoon, Dease Inlet, Admiralty Bay, portions of Smith Bay that are within the NPR-A boundary in the vicinity of the Ikpikpuk River delta, Pogik Bay and the Kogru River, as well as lakes and streams within the Reserve's boundary unless expressly conveyed (*United States of America v. State of Alaska*, No. 84, Original, June 2000).

Native Allotments

The Native Allotment Act of 1906, as amended, allowed an Alaskan Native to receive up to 160 acres of vacant, unappropriated, and unreserved land. Applicants had to show use and occupancy of lands selected.

No Native allotments were conveyed within NPR-A prior to the passage of the Alaska National Interest Lands Conservation Act (ANILCA). The NPR-A was withdrawn from the operation of the Native Allotment Act until the passage of section 905 of ANILCA, as amended (43 U.S.C. 1634). Moreover, many Alaska Natives relinquished claims they had made for Native allotments in NPR-A when they were informed that if they relinquished their claims, the village corporations would receive Alaska Native Claims Settlement Act conveyances sooner, and then the corporations would reimburse the applicants for the lands relinquished.

With the passage of section 905 of ANILCA, as amended (43 U.S.C. 1634), allotments within the NPR-A were reinstated with the exception of the allotments on lands conveyed to the village corporations of Atqasuk, Barrow, or Wainwright. Section 12 of the Technical Corrections Act of 1992 amended section 905 of ANILCA to allow the allotments on lands conveyed to the corporations within the NPR-A to be reconveyed if certain conditions were met. All three villages have completed reconveyance of lands to the U.S. for certification of the Native allotment to the applicant.

There are approximately 326 allotments comprising approximately 30,100 acres within the NPR-A. All 326 allotments have been surveyed and have been, or are in the process of being, certificated.

Village Corporation

The Alaska Native Claims Settlement Act (ANCSA) enacted in 1971 allowed the village corporations of Atqasuk, Barrow, Nuiqsut, and Wainwright to select surface lands under sections 12(a) and 12(b). The NPRPA reiterated the availability of lands for selection by and conveyance to village corporations under ANCSA. Section 12 of the Technical Corrections Act of 1992 allowed the villages to reconvey lands under a valid Native allotment application in exchange for an equal number of acres of additional selections.

Out of over 700,000 acres of entitlement lands, less than 1 percent of eligible acreage remains to be conveyed to village corporations. The acreage received and the remainder of the entitlements for Atqasuk, Barrow, Nuiqsut, and Wainwright (current as of January 2011) are shown in Table 3-22.

Table 3-22. Status of village corporation entitlements in the NPR-A

Type	Entitlement (acres)	Interim conveyed (acreage)	Patented (acreage)	Remaining entitlement (acreage)	Remaining selected (acreage)
Atqasuk Entitlements					
12(a)	69,120	13,217	55,009	894	5,443
12(b)	3,834	3,834	0	0	0
Barrow Entitlements					
12(a)	161,280	156,890	3,455	935	0
12(b)	54,530	54,530	0	0	0
BGFTA[1]	97,923	0	88,592	0	0
Nuiqsut Entitlements					
12(a)	115,200	43,610	69,880	1,710	3,822
12(b)	30,394	23,359	7,240	335	8,899
Wainwright Entitlements					
12(a)	115,200	0	115,588	0	0
TCA[2]	2,714	0	2,714	0	0
12(b)	55,670	0	55,670	0	0
Totals	**705,864**	**295,440**	**398,147**	**3,874**	**18,164**

1. Per section 3 of the Barrow Gas Field Transfer Act of July 17, 1984; Ukpeagvik Innpiat Corporation was entitled to the sand and gravel underlying the surface estate of select lands in the vicinity of Barrow.
2. Technical Corrections Act of 1992 for Replacement Lands

Regional Corporation

The Arctic Slope Regional Corporation owns 5,400 acres of surface estate in the NPR-A at Cape Halkett, which was received in exchange for the Corporation's Kurupa Lake lands (5,332 acres) on December 9, 1981. The Arctic Slope Regional Corporation owns surface and subsurface estates and sand and gravel rights within the NPR-A.

The Alaska Native Claims Settlement Act (ANCSA) did not allow the Arctic Slope Regional Corporation to select the subsurface estate within the NPR-A. However, section 12(a)(1) of ANCSA allowed the Corporation to select the subsurface estate in an equal acreage from lands outside NPR-A. Public Land Order 5183, dated March 9, 1972, confirmed the provisions of section 12(a)(1) by withdrawing the entire subsurface estate of NPR-A. The Naval Petroleum Reserves Production Act (1976) reiterated the arrangement, recognizing the village corporations' selections of surface estate as provided by ANCSA without providing for other land claims.

Table 3-23. Status of regional corporation entitlements in the NPR-A

Type	Interim conveyed (acreage)	Patented (acreage)
Arctic Slope regional corporation entitlements		
1431(o)	49,477	28,252
Exchange	149,516	13,497
Totals	**198,993**	**41,749**

Note: These do not have established entitlements; conveyances depend on the terms of legislation or agreement.

It was not until 5 years later that selections by regional corporations were allowed in the NPR-A. The Appropriations Act of 1981 (Public Law 96-514) authorized the Secretary of the Interior to lease lands within the NPR-A for oil and gas exploration and development. The passage of this Act allowed the implementation of section 1431(o) of the Alaska National Interest Lands Conservation Act by providing specific legislative authority to exchange NPR-A lands contingent upon legislative direction to open the NPR-A to commercial development.

Section 1431(o) of the Alaska National Interest Lands Conservation Act allowed the Arctic Slope Regional Corporation to select the subsurface of village-selected lands if lands within 75 miles of the village lands were made available for commercial development. The Arctic Slope Regional Corporation selected the subsurface estate under all lands selected by Nuiqsut and under a portion of the lands conveyed to Barrow and Wainwright. The Corporation will receive the subsurface estate once village entitlement for Nuiqsut has been completed in part of what is now the Greater Mooses Tooth Unit.

North Slope Borough

The North Slope Borough owns approximately 180,000 acres of surface and/or subsurface estate inside the NPR-A. Most of these lands are near Barrow and were conveyed as subsurface estate along with gas wells, pipelines, and related facilities as part of the Barrow Gas Field Transfer Act of 1984 (Public Law 96-366, Statute 468). The North Slope Borough also owns approximately 229 surface estate acres (with sand and gravel) at the former Cape Simpson Distant Early Warning-Line Station and 320 surface estate acres (with sand and gravel) in the DeLong Mountains, partially in sections 10, 15, and 16, T10S, R29W, Umiat Meridian (unsurveyed).

State of Alaska

The State of Alaska owns 1,450 acres at the Umiat Airport by a Quit Claim Deed on June 1, 1966 (U.S. Survey 9571). The deed transferred and conveyed to the State of Alaska all right, title, and interest of the United States of America in and to the real personal property identified in the deed, subject to specific rights (i.e., minerals) and uses (i.e., access) reserved by the federal government. Furthermore, the deed has a reversionary clause in the event of any breach of the covenant.

Per the Submerged Lands Act, 1953, as amended (43 U.S.C. 1301), the State of Alaska owns submerged lands and tidally influenced waters extending 3 geographic miles seaward into the Arctic Ocean, north of the NPR-A coastal boundary as described by Executive Order 3797-A, and clarified by the U.S. Supreme Court (512 U.S. 1 (1997)).

3.4.1.2 Land Uses

Authorized Use

The NPR-A is entirely within the zone of continuous permafrost and exhibits poor soil conditions. To prevent tundra damage in such conditions, the BLM is limited in its ability to approve many or most land use proposals for summer operations that require tundra travel. During the winter, when the mineral soils are frozen and stable and there is sufficient snow to protect the vegetation, it is possible to traverse the tundra with minimal disturbance by using low-impact vehicles. Winter activities such as oil and gas exploration, seismic exploration, overland moves, and research are allowed with specific restrictions on a case-by-case basis.

The types of authorizations that have customarily been issued in the planning area include: seasonal permits for research and monitoring, special recreation permits, rights-of-way, recreation and public purposes authorizations, seismic permits, mineral material sales, and oil and gas leases. Research and monitoring permits, normally for a single season, and rights-of way, issued for a term appropriate for the project undertaken, comprise the bulk of the annual authorizations issued within the Reserve. The number of current authorizations changes as authorizations are issued and expire. See Map 3.4.1-1 for a summary of areas currently under permit within the planning area.

Rights-of way within the NPR-A have been issued for several active and inactive Distance Early Warning-Line sites, including at Lonely, Kogru, Wainwright, and Barrow. See section 3.2.11 for a discussion of waste at these sites. There are also communication and navigation-related rights-of-way authorizations to other federal agencies, such as VORTEC sites, RACON sites, and communication towers. There are currently five active NPR-A-wide rights-of-way authorizations for winter tundra travel by low-pressure vehicles. These are generally for annual overland resupply moves between the various North Slope villages and oil and gas projects. When oil and gas exploration is being conducted there is an associated rights-of-way grant to the lease holder allowing them winter access to their lease. Currently there are three active rights-of-way grants to oil and gas companies.

Wells drilled by the U.S. Geological Survey (USGS) in the late 1970s and early 1980s are part of the BLM's Legacy Well program. These wells are in suspended status and have an associated authorization to preserve access to the sites for long-term permafrost research purposes. Several of these wells along the Beaufort Sea coast have been plugged and abandoned in the last 5 years. See Chapter 3, section 3.2.11, "Solid and Hazardous Wastes" for more information related to wastes at these sites.

The majority of the land use authorizations in the NPR-A are for lands located in the north and northeast portion of the planning area. Withdrawals and recreation and public purpose authorizations, seismic permits, mineral material sales and oil and gas leases dominate the land use activities in the northern portion of the Reserve. Most activity that has taken place in the southern portion of the reserve have been along the Kokolik, Utukok, Colville, Etivluk and Nigu rivers and Driftwood Creek. The authorizations that have been issued for the Kokolik, Utukok, and Driftwood have been requested due to the interest in the Western

Arctic Caribou Herd. Filming permits and special recreation permits have been issued to commercial operators for scenic guided excursions. The interest in the southern Colville River has been for commercial guided hunting. The Etivluk and Nigu river authorizations have been special recreation permits for guided scenic viewing of the area. In 2010 nine special recreation permit authorizations were issued in the NPR-A, with all but one located in the southern portion of the Reserve. The guided hunting special recreation permits allow the permittee access to a great deal of land in the Reserve, primarily in the south but also in the northern portion of the reserve. See section 3.4.6, "Recreation," for more information on special recreation permits.

The BLM also manages small parcels of discrete land at Umiat and within the community of Barrow. The authorizations granted by the BLM at Umiat include summer research permits, seismic work, and authorizations to the U.S. Army Corps of Engineers for cleanup work at formerly used defense sites. The BLM authorizations within Barrow are primarily rights-of-way grants and withdrawals. The withdrawals include a National Oceanic and Atmospheric Administration (NOAA) research site used as a climate monitoring and diagnostics laboratory, and a research site assigned to the USGS for a geomagnetic observatory. The rights-of-ways have been issued for the Barrow Utilities and Electric Cooperative power plant and the National Weather Service weather station site. There is also a recreation and public purpose area in Barrow that is used as a recreation field. These sites may become available for other uses in the future.

Access

There are no permanent roads on BLM-managed federal lands inside the NPR-A, aside from a few at old drill sites or military installations (see section 3.4.10, "Transportation" for more information). There are numerous 17(b) easements in the NPR-A providing access across private lands. BLM-managed lands are readily accessible via numerous airports, airstrips, and gravel bars to land fixed-wing aircraft. BLM-managed lands are accessible via snowmachine during winter months when surface waters are frozen and snow covers the ground. Once the Colville River freezes, a person can cross the river into the NPR-A. Given the 17(b) easements, a person may fly into a local community and travel via snowmachine to BLM-managed lands.

17(b) Easements

There are numerous 17(b) easements in the NPR-A. Section 17(b) easements were authorized by section 17(b) of the Alaska Native Claims Settlement Act, and provide access across land conveyed to Native corporations. These easements run from publicly owned land and waters to publicly owned land and waters. The uses allowed on section 17(b) easements are set by regulation and are described in the conveyance document transferring the land to the Native corporation.

Most 17(b) easements provide access through lands conveyed to village corporations and the regional corporation. There are three linear and two site easements on village corporation lands near Nuiqsut inside the NPR-A. There are 12 linear easements and 1 site easement on village corporation lands near Barrow and 3 and 4 linear easements and 2 and 0 site easements on village corporations near Atqasuk and Wainwright, respectively. Other linear easements in or immediately adjacent to NPR-A are at sites along the Colville and

Etivluk Rivers and near Umiat, while long linear easements connect public lands south of NPR-A with the Colville River and NPR-A and a few others connect the western border of NPR-A with the Chukchi Sea.

Sites

Numerous structures (primarily cabins) are located on BLM-managed lands inside the NPR-A without authorization. Before accurate numbers of structures can be determined, an inventory establishing the location and ownership of these structures must be compiled. When these actions have been carried out, the level of unauthorized use can be determined. Fish camps must also be inventoried. Although fish camps do not usually entail permanent structures, waste materials such as garbage and fuel are commonly left on site.

There are numerous airports, airstrips, and sand bars along rivers inside and outside the NPR-A that offer access to BLM-managed lands inside the NPR-A. Scheduled commuter service is available to Nuiqsut, Barrow, Atqasuk, and Wainwright. Chartered and private aircraft frequent the airstrips at Umiat, Inigok, Ivotuk, and the Lonely Distant Early Warning-Line station. There are a few unimproved airstrips on Native allotments. The airstrips at Cape Simpson, the Wainwright Distant Early Warning-Line station, Kogru Distant Early Warning-Line Station, Icy Cape Distant Early Warning-Line, and Tunalik are typically no longer accessible due to the lack of maintenance. It is not recommended that these sites be used to land fixed-wing aircraft. There are many suitable sand bars along rivers throughout the NPR-A on which fixed-wing aircraft may land.

3.4.1.3 Land Ownership and Uses and Climate Change

Land ownership under the Alaska Native Claims Settlement Act and the Native Allotment Act inside the NPR-A for the remainder of the century should generally be settled. The Arctic Ocean coastline boundary with the State of Alaska's submerged lands may become an issue due to accelerated coastal erosion and, to a far lesser extent, rising sea levels. Other issues that may arise could be requests by Native corporations, the North Slope Borough, and/or local communities to the BLM for new lands to replace their loss of coastal lands or for relocation of local communities. It is unclear if climate change will alter demand for authorized uses and public access, but land use throughout the NPR-A has the potential to change a great deal because of projected increases in snowfall, winter and summer temperatures, the active layer depth, change in vegetation, and thermokarsting.

With the predictions of an ice-free Arctic Ocean by end of the century, the U.S. Coast Guard has increased its presence in the Arctic and identified the need for infrastructure (U.S. Coast Guard 2010). Barrow has been discussed as a possible location for a deep-water port (Senate Bill 2849 and 1561, in 2009).

3.4.2 Cultural Resources

The culture history of the NPR-A mirrors that of the rest of Arctic Alaska. This history is unique when compared to the culture history of not only the rest of North America but the remainder of the Western Hemisphere in that there is strong evidence indicating the first biologically viable population of people to enter and occupy this half of the planet did so by traveling across the Bering Land Bridge from Siberia to Alaska (Crass and Holmes 2004, Guthrie 2006, Goebel et al. 2008). Although some archaeologists and other scientists have proposed more sensational and exciting theories regarding the initial peopling of the New World, archaeological, paleontological, genetic and other research has demonstrated that over the last 250 million years the movement of terrestrial animal species between the eastern and western halves of the planet has occurred via a dry land connection that has periodically existed between Asia and North America (Shapiro et al. 2004, Bolotsky and Godefroit 2004, Crass and Holmes 2004, Guthrie 2006, Goebel et al. 2008). Because prehistoric humans were dependent upon terrestrial resources, primarily animals utilized for food, clothing and shelter, it is difficult to imagine that a migrating people would not have used this land bridge and its abundant resources to move between the hemispheres. Prior to the Last Glacial Maximum, about 22,000 years ago, southward dispersal of animals from Alaska to the rest of the hemisphere occurred periodically during interglacial periods when glacial ice was minimal or non-existent[23].

Archaeological research has revealed the physical evidence of roughly14,000 years of human occupation within northern Alaska; probably the only locale on our half of the globe where human occupation can be traced from its entrada, to the present day (Kunz et al. 2003, Crass and Holmes 2004, Goebel et al. 2008). At the end of the Wisconsin Glaciation—the last Ice Age of the Pleistocene Epoch—much of Alaska and adjacent Siberia were part of a contiguous landmass called Beringia (Hultén 1937). At that time immigrant populations of humans crossed the dry land connection from Siberia (Western Beringia) into Alaska (Eastern Beringia) and over the next millennia moved southward to the southern tip of South America to inhabit this half of the planet (Guthrie 2006, Goebel et al. 2008, Meltzer 2009).

Beringia existed during the glacial episodes of the Pleistocene when world-wide sea level was as much as 300 feet lower than today and was comprised of most of Alaska, northwestern Yukon Territory and most of Siberia as well as the connecting Bering Land Bridge. Alaska north of the Alaska Range and northwestern Yukon Territory plus half of the land bridge made up Eastern Beringia, a mostly unglaciated landmass with an extreme continental climate that can be ecologically described as a steppe prairie; a dry mostly treeless landscape with a vegetative cover composed of grasses, sedges, forbs and sage an ecology which has no modern analog (Hopkins et al. 1982). Besides a number of other animals, bison, horse, mammoth, caribou, muskoxen, and moose inhabited the Arctic portion of Eastern Beringia and the people who lived there depended upon these animals—primarily bison and caribou—as a source of food, clothing, and shelter to such a degree that their life style evolved around and was tailored to the behavior and availability of these animals (Hopkins et al. 1982, Guthrie 1990, Kunz et al. 2003).

The land bridge now lies beneath the waters of the Bering, Chukchi, and Beaufort seas, which in practical terms renders the archaeological data from that area unattainable. As a result the interpretation of the initial chapter of the culture history of Arctic Alaska is based in part upon informed speculation. While most archaeologists would agree that northern Alaska was initially occupied by immigrants from Northeast Asia who crossed the land bridge from Siberia to Alaska as long ago as 18,000 years, and that some time before 13,500 years ago their descendants moved south and populated the rest of the Western Hemisphere, that is probably where practical consensus would end.

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[23] Note: All dates, unless otherwise specified, are presented as calendar years before present.

With the exception of the very recent past, all of our "hard scientific" knowledge regarding the human occupation of Arctic Alaska results from archaeological and related research. In the archaeological record cultural groups are identified by the materials they have left behind. Most frequently, these materials are stone tools, for the most part because stone outlasts tools made from organic materials. Most cultures make some readily recognizable type of stone tool, the shape, style, and manufacturing technique of which is unique to their group; a sort of material culture fingerprint or hallmark. Utilizing cultural fingerprints and other procedures such as stratigraphic position and radiocarbon dating, archaeologists can trace the culture history of Arctic Alaska through time.

As more archaeological research is conducted in Arctic Alaska, the history of human occupation becomes somewhat clearer. Such research has demonstrated that during the region's initial period of occupation—around 14,000 years ago—a cultural group that relied primarily on a technique called bifacial reduction for the manufacture of stone tools, particularly lanceolate projectile points of distinctive style and shape, occupied Arctic Alaska. This cultural entity is archaeologically known as the Mesa Complex and its genesis appears to be completely North American since there is no evidence in Western Beringia for a progenitor cultural group whose stone tool industry is based on bifacial reduction (Vasil'ev 2001, Slobodin 2001, Goebel et al. 2008). Further, the Mesa Complex is nearly identical technologically and stylistically to the stone tool industry of the earliest inhabitants of the North American High Plains, the Paleoindians—Clovis, Folsom, Agate Basin, etc. Another Arctic archaeological culture, the Sluiceway Complex, is also present, primarily in the southwest portion of the NPR-A during the same time period and is so technologically similar to Mesa that the two Complexes can probably be considered slightly different manifestations of the same cultural entity.

As a point of clarification it should be mentioned that shortly after its discovery it was argued by a number of archaeologists that the Mesa Complex's presence in Arctic Alaska was the result of a backwash of High Plains Paleoindian influence moving northward through an ice-free corridor between the Cordilleran and Laurentide ice sheets along the east flank of the Rocky Mountains. In the early 1990s, the evidence indicated that the ice-free corridor was usable by humans around 14,000 years ago (Mandryk 1993) which slightly predated the age of Mesa. It was also pointed out that most of the radiocarbon dates for the Mesa Complex ranged between 12,500 and 11,900 years ago, younger than Clovis and well into the Paleoindian time period, while only two dates, 13,200 and 13,700 years ago, were as old or older than Clovis and thus more ancient than the High Plains Paleoindians. It wasn't until the Sluiceway Complex was identified 15 years after Mesa and the Sluiceway radiocarbon dates demonstrated the same chronology as Mesa—one period of occupation about 12,000 years ago and another at about 13,200 years ago—that general acceptance of the older Mesa dates occurred (Rasic 2000, Kunz et al. 2003, Kunz 2008, Rasic 2008). Additionally, ice-free corridor data obtained over the last 15 years suggests that the route may not have been usable by humans until around 12,500 years ago, roughly 1,000 years after Mesa is established in Arctic Alaska (Hundertmark et al. 2002, Shapiro et al. 2004, Arnold 2006). Both the age of the Mesa and Sluiceway Complexes and the probability that the ice-free corridor was not usable before about 12,500 years ago suggests that the backwash origin theory for those complexes is a highly unlikely reality.

It is quite interesting that archaeological research has shown that cultural groups in Western Beringia, the assumed progenitors of the Mesa Complex, had a stone tool industry that was very different from that in Arctic Alaska. For millennia prior to, during, and after the initial migrations across the land bridge, the generalized stone tool industry of cultural groups in Siberia was based on core and blade reduction technology (Slobodin 2001, Goebel, et al. 2008). While at least one late Pleistocene Western Beringian stone tool assemblage, the Dyuktai Complex, includes a bifacial element, that element is not a primary component of the assemblage as are blades and microblades, and the cores from which they were struck (Mochanov 1969, Vasil'ev 2001).

In relation to this, it should be noted that there appears to be at least one example of the Western Beringian Dyuktai core/blade/biface assemblage in Eastern Beringia. The Swan Point site about 75 miles east of Fairbanks has an artifact assemblage that is quite similar to that of the Dyuktai Culture (Holmes and Crass 2003, Crass and Holmes 2004). In Siberia, dates for the Dyuktai Culture range from 18,000 to 14,000 years ago (Mochanov and Fedoseeva 1996). The date for the similar assemblage at Swan Point is 14,300 years before present, making it about 600 years older than the Mesa Complex and the oldest securely dated site in Alaska (Holmes and Crass 2003).

So where did the bifacial stone tool technology of the early inhabitants of Eastern Beringia come from? In an effort to sort out this conundrum the following scenario, although to a large degree speculative, appears to be a reasonable interpretation of the evidence.

Following the Last Glacial Maximum, approximately 22,000 years ago, microblade/blade cultures began moving northeastward across Western Beringia and crossed onto the land bridge perhaps as early as 18,000 years ago; although at present no archaeological sites of that age have been found along Siberia's land bridge margin. The area of the land bridge was nearly the size of Alaska, about half a million square miles. Because the general path of migration was probably directionless—groups meandering from one high-density resource area to another—it may have taken centuries before seasonal movements and the patterns of daily living brought these earliest immigrants to the northwestern corner of North America. At this time, with the exception of the Brooks Range, Alaska from the Arctic south to the Alaska Range was unglaciated as was the land bridge and most of Western Beringia. However, the vast Laurentide Ice Sheet, which covered most of Canada and the Cordilleran Ice Sheet in southern Alaska, the adjacent portion of the Yukon Territory and British Columbia were blocking any movement out of northern Alaska (Mann and Hamilton 1995, Mandryk et al. 1998). As a result, unglaciated Alaska, cut off from the rest of the hemisphere by glacial ice, acted like an enormous corral, confining the recently arrived human population. Over time, some of these immigrant cultural groups probably intermixed and blended developing a new cultural identity and technology partially in response to the unstable and changing environmental conditions that marked the end of the Pleistocene. At the same time, more recently arrived or geographically isolated groups may have remained unchanged in terms of the cultural and technological orientation they had brought with them from Western Beringia. Evidence supporting this scenario may be seen in the Swan Point site and Nenana Complex sites in interior Alaska and the Mesa and Sluiceway Complex sites in Arctic Alaska (Bever 2000, Kunz et al. 2003, Kunz and Baker 2005, Kunz 2008). By about 16,500 years ago the glacial ice that covered the Alaska Peninsula and Queen Charlotte Islands receded enough to allow passage southward out of Alaska into the temperate latitudes via a coastal route (Fladmark 1979, Mann and Hamilton 1995, Mandryk et al. 1998, Meltzer 2009). Many archaeologists are of the opinion that it was by this coastal route that people first moved out of the Arctic and dispersed southward (Haynes 2002, Meltzer 2009). This may be evidenced by the fact that the most ancient artifact assemblages found along the western margin of the land masses south of the glacial ice appear to be hallmarked by unfluted lanceolate projectile points that are stylistically very similar to those of the Mesa and Sluiceway complexes (Cruxent 1956, Butler 1967, Rice 1972, Dillehay 1997, Smith 2009)

The oldest, well documented and securely-dated archaeological site in Alaska and all of North America is Swan Point (Holmes and Crass 2003). On the other hand, the oldest radiocarbon-dated microblade manifestations in Arctic Alaska are dated at 12,200 years ago (Hedman 2010) about 1,500 years younger than the Mesa Complex. In summary, the oldest known site, Swan Point, which lies in interior Alaska, contains microblades. Therefore, given its proximity to the land bridge, there should be a microblade site of equal or greater age in Arctic Alaska; and there probably is, it just has not been found yet. So, based on what we do know, the following is a description and chronological ordering of the cultures of Arctic Alaska as they appear at present (see also Table 3-24 on page 379 for a summary).

3.4.2.1 Cultures of Arctic Alaska

Paleoindian Tradition (13,700 to 11,800 years ago)

Although Arctic Alaska may well be the region where the Paleoindian culture and stone tool industry first evolved, it is not where Paleoindians were first recognized. Paleoindians were first identified 85 years ago (1927) in an archaeological site more than 3,000 miles to the south near Folsom, New Mexico. It was not until 1978 that a classic Paleoindian assemblage, the Mesa Complex, was recognized in Arctic Alaska. This Arctic Paleoindian manifestation is at least as old as Clovis, which has caused archaeologists to reexamine theories regarding the peopling of the New World (Kunz 1982, Kunz and Reanier 1994, 1995, Reanier 1995, Kunz et al. 2003). Since the middle of the last century, Paleoindians have been considered by most researchers to represent the first indigenous, geographically widespread, North American cultural tradition (Kunz and Reanier 1994 and 1995, Haynes 2002, Meltzer 2009). The Paleoindians are known for their excellent stone tool manufacturing techniques, producing distinctive edge-ground, bifacial, lanceolate projectile points, knives, spurred-end scrapers, and multi-spurred gravers.

Radiocarbon dated Paleoindian sites in Arctic Alaska include Bedwell/Putu on the Sagavanirktok River, Hilltop in the Atigun River Gorge, Mesa in the Iteriak Creek Valley, Irwin Sluiceway in the Anisak River drainage and Tuluaq Hill on Wrench Creek (Kunz 1982, Kunz and Reanier 1994 and 1995, Reanier 1995, Kunz et al. 2003, Rasic 2000 and 2008). A recently discovered site on the Kivalina River, Raven Bluff, has produced a radiocarbon date of 12,200 years ago for a fluted lanceolate point type (Hedman 2010). While this point style had long been recognized as having wide distribution across Arctic Alaska and the Yukon, examples of these points had been found only as surface isolates in undateable contexts (Reanier 1995). The Raven Bluff radiocarbon date confirms the point style as an element of the Northern Paleoindian tradition (Kunz and Reanier 1994). Fluted projectile points are a hallmark of Clovis and Folsom assemblages and are diagnostic of the two oldest component cultures of the Paleoindian tradition on the High Plains. It is worth noting however, that at Raven Bluff, fluted projectile points may be associated with microblade technology, which is not considered an element of classic Paleoindian assemblages. The presence of fluted projectile points appears to indicate that the ice-free corridor was usable by about 12,500 years ago and that northward moving fluted point technology arrived in the Arctic by that route and became associated with microblade technology already resident in that region (Hedman, W.H., 2011, personal communication).

A note of clarification is due here regarding microblades and the Mesa Complex. Alexander (1974, 1987) reported the presence of microblades at the Putu site. Subsequent investigation at the site as well as examination of the previously recovered artifacts demonstrated that naturally produced stone spalls had been misidentified as microblades (Bever 2006). While there is a small area at the Mesa type site that contains microblades, the microblades are not part of the Mesa artifact assemblage and most likely date to a more recent occupation of the site by a culturally distinct group of people. The bulk of the microblades are made of an exotic material which none of the Mesa Complex artifacts are made from (Bever 2008). Microblades have not been found at any other Mesa Complex sites.

In Arctic Alaska the Paleoindian tradition is represented by the Mesa and Sluiceway Complexes and the Raven Bluff assemblage. This material is hallmarked by fluted and unfluted, heavily edge-ground, lanceolate projectile points and ranges from the Arctic Coastal Plain, through the Arctic Foothills and throughout the Brooks Range. There are undoubtedly archaeological sites relating to these cultures on the now submerged land bridge. Because they result from a small and very ancient population Paleoindian sites are not numerous. However, as research continues more sites will certainly be found.

It is interesting to note that the radiocarbon chronology for both the Mesa and Sluiceway complexes indicates they are absent from the region between about 13,200 and 12,000 years ago (Kunz and Reanier 1994 and 1995, Rasic 2000, Kunz et al. 2003, Rasic 2008, Kunz 2010). This temporary absence of the earliest Arctic cultures coincides with a dramatic climate change event known as the Younger Dryas; a reversal of the terminal Pleistocene warming trend to a full glacial climate (Mann et al. 2002, 2010). The absence of these cultural complexes during the Younger Dryas and their presence during the warmer periods before and after the Younger Dryas, suggests that supporting human life in the Arctic at a reasonable comfort level during a full glacial climate was beyond the capabilities of a stone-age technology. As previously noted, the initial migration of humans across Subarctic/Arctic Siberia into Arctic/Subarctic Alaska took place during the warm period following the Last Glacial Maximum—not during the extremes of a full glacial climate.

Almost without exception Arctic Paleoindian sites occur on elevated land forms such as hill/bluff tops and ridge lines that provide extensive views of the surrounding countryside. Based on their setting and the artifacts recovered, the sites can be characterized as hunting lookouts and may be indicative of a different hunting strategy than was employed later during the Holocene. The greatest density of these sites occurs along the northern face of the Brooks Range and the adjacent foothills. As of this date, probably more locales of Paleoindian activity have been found in the southern portion of the NPR-A than in any other area in Arctic Alaska (Alaska Heritage Resource Survey 2011). While this circumstance may be the result of the amount of fieldwork conducted there, the area is rich in resources and the potential for finding additional sites that will shed more light on some of the first indigenous people to inhabit the New World is extremely high.

As previously mentioned, during this time period there was no Arctic coast and therefore, unlike the cultures that followed them, the Paleoindians were perhaps the only residents of the Arctic that had no coastal orientation. However, there were plenty of rivers in the region and given the sophisticated sewing technology that is required to live in the Arctic, there is little doubt that they manufactured and utilized watercraft.

As the Pleistocene transitioned into the Holocene, the global climate warmed, sea level rose and the landscape changed significantly across Arctic Alaska. As the ecosystems reorganized themselves, the vegetation changed from that of a steppe-prairie to tundra. This degree of habitat change—a shift from a dry grassland underlain by a firm substrate to a tundra comprised of a moist heath/sedge ground cover underlain by a peaty/spongy substrate—was probably the most extreme and dramatic of any that occurred anywhere on the planet (Hopkins 1982, Guthrie 1990). Most of the large Ice Age mammals were not adapted to a tundra biome and disappeared from the region. The Paleoindians vanished from northern Alaska's archaeological record at the same time (Kunz et al. 2000, 2003).

American Paleoarctic Tradition (11,800 to 8,000 years ago)

The microblade technology of this cultural entity suggests its origins lie in Siberia. In Arctic Alaska it overlaps with the end of the Paleoindian period. Although its cultural flavor is Siberian, technologically the American Paleoarctic tradition is loosely defined (Anderson 1968 and 1970, West 1981, Dumond 1987). Microblades and wedge-shaped microblade cores are the hallmarks of this tradition's stone tool assemblage, which also includes burin technology, a variety of bifacial projectile points, large bifaces, blades, and incidental tools. Because most of the lithic components of this tradition are temporally amorphous, particularly the microblade cores, making cultural assessment of undated sites is difficult. While there are some sites in Arctic Alaska that technologically appeared to belong to this tradition, such as Lisburne (Bowers 1982) on Iteriak Creek and a large site on Kurupa Lake (Schoenberg 1995), neither has been reliably dated. Recently TES-057, a site located on Kealok Creek south of Teshekpuk Lake, has been radiocarbon dated to 11,800 years ago (Reanier 2005). Other dated American Paleoarctic sites in northern Alaska such as the Gallagher Flint Station near the University of Alaska's Toolik Field Station date near the more recent end of the time period (Ferguson 1997).

Based on radiocarbon dates, the people of this cultural tradition appear in the archaeological record of Arctic Alaska slightly before the end of the Paleoindian period at the onset of the Holocene. By then the land bridge was being inundated by a rising sea level and climate, landscape, and regional ecology were changing dramatically. Global warming and its accompanying increase in atmospheric moisture resulted in increased annual precipitation and cloud cover (Mann et al. 2002, 2010). As a result the firm, dry steppe-prairie of the Pleistocene had been replaced by moist, tussock tundra which significantly reduced human mobility on the landscape. In terms of subsistence resources, mammoth and horse were long gone and, if present, bison numbers were extremely low. At the same time caribou numbers also appear to have been low. Although muskoxen and moose were present they were not numerous enough to constitute a reliable subsistence resource. These circumstances suggest that making a living in Arctic Alaska during this period may have been more difficult than it had been earlier. That probability is supported by the fact that there are few known archaeological sites in the region that date to this time period.

Given the description of its artifact assemblage, the American Paleoarctic tradition may be little more than a convenient catch-all through which archaeologists can deal with a time period that has generated confusing and possibly contradictory circumstances. However, if it does reflect some degree of reality then two intriguing questions concerning the culture history of Arctic Alaska and North America can be posed: What is the relationship between the American Paleoarctic tradition and its contemporaries in Siberia and what is the relationship between those cultural entities and the Arctic Paleoindian tradition? These questions bear on aspects of the arrival, interaction, and dispersal of modern humans throughout North America and the Western Hemisphere. While archaeological sites in the NPR-A have already provided valuable information concerning these questions, there is little doubt that undiscovered sites in the region will contain additional information.

Given the physical location of the known Paleoarctic sites Paleoarctic peoples do not seem to have been as concerned about having an extensive view-shed as did the Paleoindians. Most of the known sites are situated where they could serve as both a campsite and a reasonably good lookout. This seems to indicate that Paleoarctic people were probably caribou hunters, suggesting the absence of remnant Pleistocene megafauna.

While known American Paleoarctic sites are few in number, they are found in all the physiographic provinces of Arctic Alaska. Within the NPR-A, they are most common along the northern face of the Brooks Range and the adjacent foothills.

At the beginning of this period, there was no Arctic coast and therefore no aspects of coastal orientation for the people of the American Paleoarctic tradition. By the end of this period, inundation of the land bridge was relatively complete. However, any coastal sites associated with this tradition are, today, under water. It is also difficult to guess what marine resources may have been available because the marine ecology in the region was still forming.

Northern Archaic Tradition (8,000 to 3,000 years ago)

The late Pleistocene/early Holocene cultures were followed by a cultural continuum known as the Northern Archaic tradition (Anderson 1968). Probably less is known about the cultures of this tradition than any other in Arctic Alaska. The primary hallmark of the stone tool assemblages of this tradition is large, bifacial side-notched projectile points. Other common elements are large scrapers, bifacial knives, and burins. While not always present, microblade technology is a common occurrence in which wedge-shaped microblade cores predominate although other core types such as tabular and conical also occur. The microblade and burin technology of the Northern Archaic tradition suggest that it may have evolved out of the American Paleoarctic tradition.

By the time Northern Archaic tradition peoples appeared in Arctic Alaska, the land bridge was completely submerged and the landscape is much as it is today, predominately tundra (Mann et al. 2002, 2010). While muskoxen and moose were present, caribou were the only numerous large herbivore in Arctic Alaska during this time period and Northern Archaic peoples were probably periodically affected by the dramatic cyclical rise and fall of their numbers. However, unlike the earlier Arctic Alaskan cultures, Northern Archaic tradition sites are commonly found well into interior Alaska, suggesting both a tundra and woodland orientation. This evidence also implies a fair degree of mobility perhaps indicating response to fluctuating resources and/or annual seasonal movement. Despite this implied propensity to exploit a variety of ecosystems, although Arctic Alaska now had a stable marine coastline, the archaeological evidence does not indicate that Northern Archaic people spent much time utilizing the marine environment.

In Arctic Alaska most of the known Northern Archaic sites occur in the Brooks Range and its northern foothills. Excavation has occurred at two large sites in the region, Tuktu, near Anaktuvuk Pass (Campbell 1961) and at Kurupa Lake (Schoenberg 1995). Both of these sites date to around 7,500 years ago and may be good age indicators for other large undated Northern Archaic Sites in the region such as Lisburne on Iteriak Creek (Bowers 1982, 1999) and KNA-15 on the Kuna River, both in the southern NPR-A (Kunz 2001, Kunz and Adkins 2007). A number of smaller Northern Archaic sites has also been noted in the southern NPR-A and these may provide additional information regarding this poorly understood cultural tradition (Davis et al. 1982, Dawe 2003, Dubé 2006). It is reasonable to assume that there are a number of yet undiscovered Northern Archaic sites in the NPR-A which could contribute significantly to the understanding of this tradition.

Arctic Small Tool Tradition (5,000 to 2,400 years ago)

In the opinion of many archaeologists, the Arctic Small Tool tradition is the most intriguing cultural tradition in the Arctic. It is the beginning of what is referred to as the Eskimo Cultural Continuum, a cultural manifestation that was organized differently and exploited the regional resources differently than had the preceding cultural entities. While its roots may lie in Siberia, its birthplace as an identifiable cultural entity in the archaeological record lies in Alaska. It is interesting that the Arctic Small Tool tradition's seemingly sudden appearance is associated with a climatic shift, the end of the Holocene Warm Period. The Arctic Small Tool tradition was defined by archaeologist William Irving (1962, 1964) after several seasons of excavation at a Denbigh Flint Complex site at Punyik Point on Etivluk Lake which lies in the southernmost extent of the NPR-A. Irving saw a strong technological relationship between the Denbigh Flint Complex Culture, the Pre-Dorset (Sarqaq) Culture and the Independence I Culture of the central and eastern Arctic (Canada and Greenland). Together these cultures comprise the Arctic Small Tool tradition, a tradition which expanded across the Arctic from Alaska to Greenland, a surface distance of nearly 5,000 miles, in less than 500 years (Kunz 2006).

As its name implies, the Arctic Small Tool tradition is typified by a variety of small, bifacially flaked stone tools. Among these are end and side blades which are usually combined as insets in a slotted antler or ivory shaft to make a composite projectile point, microblades, and mitten-shaped (stack-step) burins. Of the three cultures that make up the Arctic Small Tool tradition the Alaskan representative is called the Denbigh Flint Complex (Giddings 1951).

The Denbigh Flint Complex (5,000 to 2,400 years ago) can be viewed as the oldest of the Eskimo continuum cultures and the founding and geographically farthest west culture of the Arctic Small Tool tradition (Irving 1961, 1964). The Denbigh Flint Complex stone tool industry is defined by small, well made, delicate, bifacial, end and side blades utilized in the manufacture of composite tools, as well as flake knives, burins, and microblades (Giddings 1951). The end and side blades, burins, and often flake knives and discoids exhibit parallel oblique flaking, a distinctive Denbigh Flint Complex trait. However the most distinctive element of the Denbigh Flint Complex stone tool industry is the burin.

This tool is manufactured and used in such a way that as the implement is resharpened, by the removal of spalls, a pattern of sequential notches is created along one edge rendering its appearance unmistakable from any other stone tool. Microblade technology is also a defining element of the Denbigh Flint Complex, particularly the manufacture of large microblades which often had tools made on them or were used as shaft insets. Microblade technology does not occur in any of the other Eskimo continuum cultures. In short, of all the cultures present in Arctic Alaska, the Denbigh Flint Complex is the most easily and readily recognized from the components of its stone tool assemblage.

The Denbigh Flint Complex time period overlaps with the last half of the Northern Archaic period and it is quite probable that these two groups may have interacted with each other. However the number of Denbigh Flint Complex sites on the Arctic Alaska landscape is much greater than the number of Northern Archaic sites, suggesting that the Denbigh Flint Complex population was much larger. In fact, as a cultural entity the Denbigh Flint Complex occupied a much more extensive area than did the earlier Paleoindians or any of the subsequent Eskimo cultures of Arctic Alaska. Probably the primary reason the Denbigh Flint Complex was so prolific was that its people exploited coastal, tundra, montane and woodland environments (Kunz 2006, Slaughter 2006). However, even in coastal sites where the Denbigh Flint Complex people hunted sea mammals, primarily seals, their tool kit appears to have been more oriented toward hunting caribou (Giddings and Anderson 1986). Denbigh Flint Complex sites are common throughout the Brooks Range hundreds of miles from the coast and the range of the Denbigh Flint Complex people extended at least as far south as that of the historic Nunamiut Eskimo (Kunz and Slaughter 2001).

Prior to the appearance of the Denbigh Flint Complex in Arctic Alaska, flaked stone tools were almost exclusively made from chert, a rock type that is an excellent tool stone and is abundant throughout the central and western Brooks Range. Obsidian (volcanic glass) which is also a tool stone shows up only infrequently in the region's archaeological sites that are not Denbigh Flint Complex and/or are more than 5,000 years old. While the Denbigh Flint Complex people made the majority of their stone tools from chert they also used obsidian, and to a greater degree than cultures that preceded or followed them. Geochemical analysis of obsidian from Arctic Alaska sites indicates that more than 95 percent of the glass comes from Batza Téna, an obsidian source in interior Alaska located on the Indian River 200 miles south of the southernmost point in the NPR-A (Clark and Clark 1993, Cook 1995, Kunz et al. 2001 and 2003, Reuther et al. 2008). The increased use of the Batza Téna obsidian source by the Denbigh Flint Complex people is further evidence of their mobility, larger and more geographically widespread population, and established trading networks.

While the majority of known Denbigh Flint Complex locales appear to have been open sites, resulting from caribou skin tent camps, which are usually occupied during the more clement months (Kunz 2006), semi-subterranean house remains have also been found (Irving 1962, 1964). It is believed that semi-subterranean houses usually indicate a winter occupation, as a semi-subterranean house provides better protection from the harsh winter conditions than does a skin tent. However, historically people did not occupy semi-subterranean houses in the summer, since they tended to become flooded with meltwater. Although only a few have been excavated, Denbigh Flint Complex houses appear to be rectangular and about 10 by 8 feet in size, and were probably excavated no deeper than 3 feet below the surface. A willow framework arched over the excavation and supported a roof of sod blocks sheathed by caribou skins (Kunz 2006).

Although Denbigh Flint Complex sites are found throughout the NPR-A, the greatest density of known sites occurs in the Brooks Range and adjacent foothills. The large Denbigh Flint Complex sites that have been excavated in Arctic Alaska are Croxton and Punyik Point (both in the south NPR-A), Kurupa Lake, Mosquito Lake, and the Gallagher Flint Station; all lie along the northern edge of the Brooks Range. The average age of the Denbigh Flint Complex occupation at these sites falls between 4,200 to 3,400 years ago (Kunz 1977, Schoenberg 1995, Bowers 1983, Reuther and Gerlach 2005, Slaughter 2006). However, at Mosquito Lake there are dates that indicate that Denbigh Flint Complex people were occupying the site as late as 2,600 years ago (Kunz 1977), and a date from the Gallagher Flint Station suggests a similar late occupation by Denbigh Flint Complex people (Slaughter 2006). A date of around 2,400 years ago that appears to be associated with Denbigh Flint Complex materials was obtained at the Walakpa site near Barrow (Stanford 1971, 1976). At present, Denbigh Flint Complex sites are the oldest radiocarbon dated sites on the Arctic coast.

Choris (3,800 to 2,200 years ago)

Choris is somewhat problematic. Most of the dated sites relating to that culture are found on the Choris Peninsula near Kotzebue (Giddings 1957, Giddings and Anderson 1986). A few sites along the north face of the Brooks Range such as Ribdon, Ipnaq, and the Gallagher Flint Station appear to be Choris, or contain a Choris component and have yielded dates around 2,400 years ago (Bacon 1975, Slaughter 1974, Bowers 1983). The Choris-type site dates range between 2,800 and 2,400 years ago. Some archaeologists view Choris as being transitional between Denbigh Flint Complex and the Norton Culture. Denbigh Flint Complex and Choris dates appear to overlap to a degree, as do Choris and Norton dates. There are some similarities in the Choris and Denbigh Flint Complex stone tool assemblages such as burins and parallel oblique flaking. However, Choris burins are not of the Denbigh Flint Complex type nor are they of a uniform morphology. Parallel oblique flaking, common on Denbigh Flint Complex tools, does occur on some Choris projectile points, but on no other tool types. Additionally, Choris assemblages contain the earliest pottery, ground stone tools and implements of bone, antler and ivory, which are generally absent in the Denbigh Flint Complex. However, the lack of some of these implements in the Denbigh Flint Complex may in large part be attributed to the fact that being organic they have succumbed to the rigors of time.

Although most of the known Choris sites occur in the Choris Peninsula area, the culture seems to oriented more toward terrestrial rather than marine resources as caribou remains slightly out-number those of seals at most sites.

None of the Cape Krusenstern beach ridge sites has displayed a Norton-Choris-Denbigh sequential stratigraphy, although some sites there and near Barrow have yielded a mix of artifacts attributable to these cultures (Stanford 1971 and 1976, Giddings and Anderson 1986). It is noteworthy that differences in the artifact assemblages between Choris sites often appear to be on a scale that exceeds the acceptable limits of inter-site variability thus rendering the description/definition of Choris to be rather loose. In addition, artifacts such as small end and side blades that are common in the stone tool assemblages of other

Eskimo continuum cultures appear to be limited in Choris sites when present and absent from others (Giddings and Anderson 1986). The paucity of these artifacts is telling, as they are essential in the manufacture of composite tools, which is probably the most significant trait common to all cultures of the Eskimo continuum. Further, the dates attributed to Choris that range between 3,800 to 3,000 years ago seem too old if Choris is transitional between the Denbigh Flint Complex and Norton in the Eskimo continuum sequence.

As with Denbigh Flint Complex, it is believed that Choris people probably used caribou skin tents during the warmer months of the year. There is also evidence that semi-subterranean houses were used as well, possibly year-round in some cases (Giddings and Anderson 1986). However, unlike the Denbigh Flint Complex houses and the houses of the other Eskimo continuum cultures, which are most often rectangular, the Choris houses are round (Giddings 1957).

In the final analysis, it appears as though there are enough inconsistencies, both temporal and material, between Choris and the cultures of the Eskimo continuum to suggest that Choris does not comfortably fit in the overall cultural lineage. If Choris was spawned by the Denbigh Flint Complex, it appears that it may be to an evolutionary dead end. In short, it seems to be less difficult to exclude Choris from the Eskimo continuum cultural sequence than it is to include it. Additional research may help to clarify this issue. At present, with the possible exception of the Coffin site at Walakpa Bay near Barrow (Stanford 1971), there is little indication of the presence of such sites in the NPR-A.

Norton (2,600 to 1,800 years ago)

As was the case with the Denbigh Flint Complex, the people of the Norton culture exploited the resources of the Arctic coast, coastal plain, foothills, and mountains. While the Norton people appear to have been equally comfortable in all those environments, there is a suggestion that even at coastal sites they were slightly more oriented towards terrestrial rather than marine resources (Giddings and Anderson 1986). In fact their geographic range closely mirrors that of the Denbigh Flint Complex and although they do not seem to be quite as ubiquitous on the landscape, there are numerous Norton sites scattered across the NPR-A.

While Norton shares some assemblage traits with Choris such as pottery and ground stone implements, it seems to share more with the Denbigh Flint Complex. Although the Denbigh Flint Complex microblade and burin technology is absent in Norton, side and end blades, flake knives, and discoids are common and except for the absence of parallel oblique flaking are identical to those of the Denbigh Flint Complex. While some of the Norton end blades are stemmed, the artifact that is most distinctly Norton is a small pentagonal edge-ground projectile point, which does not occur in any of the other Eskimo continuum assemblages. The presence of stone lamps, which burned animal fat and were used to provide heat and light; as well as labrets, objects used as mouth adornments; in the Norton assemblage marks the debut of these implements amongst the Eskimo continuum cultures. Additionally, tools of bone, antler, and ivory, many of which represent component parts of composite tools, occur with greater frequency than in the preceding cultures, although in part this may be due to a higher survivability rate because of less elapsed time since the sites were abandoned.

Overall, other than the presence of pottery, none of the Norton tool types suggest that these people were living any differently than the earlier Denbigh Flint Complex people. This strong similarity is probably because caribou continued to be the primary subsistence resource providing food, as well as materials for clothing, shelter, and tools. The Norton people also used the same types of dwellings that were used by the Denbigh Flint Complex people.

There are few "pure" Norton sites; in other words, a site at which there is no other cultural manifestation present. This is frequently the case among the Denbigh Flint Complex, Norton, and Ipiutak cultures as well, as a site at which any one of these cultures is present will often have a cultural stratigraphy in which the other two are also present. This circumstance suggests that the subsistence orientation of these cultures was similar and that ecosystems of the region remained relatively stable from 5,000 to 1,200 years ago. An Eskimo Continuum site that contains evidence of occupation by only a single culture is usually small, suggesting very brief use of the locale, most likely representing a stop of a few days or less while traveling.

Sites that have a Norton component are found across the NPR-A with coastal manifestations in the Barrow and Wainwright areas, on the coastal plain in the vicinity of the Pik Dunes and in the foothills/mountains region along the Kiligwa and Kuna rivers and at Etivluk and Tukuto lakes. The highest density of known sites occurs in the Brooks Range and adjacent foothills (Alaska Heritage Resources Survey 2011).

Ipiutak (1,800 to 1,200 years ago)

Ipiutak follows Norton in the Eskimo cultural continuum and while the primary aspects of the culture are the same, there are some dramatic differences, particularly those of a social rather than cultural nature. The Ipiutak flaked stone tool inventory is much the same as Denbigh Flint Complex and Norton, particularly in terms of end and side blades, discoids, and flake knives (Larson and Rainey 1948). There is also a strong similarity with the Norton bone/antler/ivory industry. On the other hand, like the Denbigh Flint Complex, all known Ipiutak manifestations contain no pottery, and no ground stone tools or lamps (Larson and Rainey 1948, Giddings and Anderson 1986). Since these three items could be construed as technological advancements introduced into the Eskimo Continuum by the Norton culture, it seems odd that they were not carried over to Ipiutak along with the flaked stone and bone/antler/ivory tool industries.

What really sets Ipiutak apart is a variety of somewhat strange artistic objects recovered in large part from burials at the type site at Point Hope, including intricate ornamental ivory carvings, such as chains and masks composed of carved ivory eyes with jet pupils and ivory mouth covers (Larson and Rainey 1948). The Point Hope site is huge with more than 600 semi-subterranean houses (not occupied simultaneously), and as such is quite atypical of all other Ipiutak sites which are much smaller. Although less numerous than Denbigh Flint Complex or Norton sites, Ipiutak sites are found in both coastal and interior settings and, as with their predecessors, they appear more oriented toward exploiting terrestrial rather than marine environments. There are Ipiutak sites scattered across the NPR-A with the largest occupations at Tukuto and Etivluk lakes and at several locations along the Kuna River (Alaska Heritage Resources Survey 2011).

Birnirk (1,600 to 1,000 years ago)

While the Birnirk people were contemporaries of the Ipiutak people, Birnirk subsistence activity trended in a different direction. The most distinctive feature of the Birnirk tool assemblage is the wonderfully carved and decorated ivory harpoon heads. Not only their presence but their numbers indicate the movement towards a greater exploitation of marine resources than had been the case with earlier coastal residents (Ford 1959, Spencer 1959). While it does not appear that the Birnirk people were more than occasional whalers, they did hunt seals and walrus extensively. They also harvested fish and waterfowl, and caribou continued to be an important element among their subsistence resources. Flaked stone side and end blades, as well as ground slate tools such as ulus, were common elements of their lithic industry as well as numerous implements of bone, antler, and ivory including harpoon heads, tool handles, and composite tool parts.

Although it is believed that skin boats have been part of every Arctic culture's tool kit since the end of the Pleistocene, the Birnirk people's increased emphasis on maritime resources suggests an increased use of skin boats, and possibly the construction of larger boats than was the case previously. While increased use of watercraft undoubtedly enhanced the mobility of these people along the coast, unlike the earlier Eskimo continuum cultures, they do not appear to have ventured very far inland. They are known from sites along the coast from Kotzebue to Barrow (Giddings and Anderson 1986). For much of the year these people lived in semi-subterranean houses on the Arctic coast although they certainly made forays inland.

Thule (1,000 to 400 years ago)

About 1,000 years ago, the Thule culture appears in Arctic Alaska's archaeological record. The development of this culture appears to have been strongly influenced by two events—the warming of the climate, which affected the distribution and character of the sea ice, and the invention of the dragfloat which is integral to successful open-water whaling. Associated with this was the continued development and use of large, open, skin boats. The Birnirk emphasis on marine resources was continued and intensified by their Thule descendants who raised open-water whaling to a level never before attained in the Arctic. The tool kit of the Thule people was almost identical to that of the Birnirk culture and included flaked stone end and side blade insets, ground stone implements, pottery, along with the addition of specialized implements of stone, bone, antler and ivory directly associated with the pursuit and capture of bowhead whales (Ford 1959, Larson and Rainey 1948, McCartney 1980, Giddings and Anderson 1986).

As a result of the moderation in the climate and the technological advances associated with whaling, the Thule people spread across the Arctic as rapidly and nearly as completely as had the Arctic Small Tool tradition people nearly 3,000 years earlier. However, the rapid expansion of the Thule people was predicated on a maritime orientation which kept them geographically focused on the coast and coastal plain, whereas the earlier Arctic Small Tool tradition people were more terrestrially oriented occupying the coast and areas hundreds of miles inland as well. At some point, probably about 400 years ago, the Thule people became what is recognized as the modern Inupiat who were first encountered by Europeans in the late 1700s.

Late Prehistoric Eskimo (700 to 400 years ago)

From roughly the end of the Ipiutak period, about 1,200 years ago, until about 700 years ago, there appears to be a time of very limited occupation and exploitation of interior Arctic Alaska. This apparent hiatus is based upon a lack of known archaeological sites that date within this period and could simply reflect the need for further research. However, the amount of archaeological survey conducted in the region should have turned up at least a few sites if they were present in even limited numbers. This makes some sense when coupled with the fact that Arctic Alaskan Eskimos are less oriented toward terrestrial resources that are not in close proximity to the coast during this period than they had been previously.

About 700 years ago, the interior of Arctic Alaska began to be utilized by people who construct semi-subterranean houses, usually with associated cache pits (Kunz et al. 2005). As was the case in earlier times, these houses are almost always clustered along the shores of large lakes and the remains of caribou-drive lines are often found nearby. The people of this time period are referred to as Late Prehistoric Eskimos and although they overlap in time with the coastal Thule people, they do not seem to be Thule people living in the interior. This determination is based on differences in the artifacts found in Late Prehistoric Eskimos and Thule tool assemblages. Prior to Birnirk times, Eskimo continuum cultures such as Denbigh Flint Complex, Norton, and Ipiutak displayed little difference in their tool kit whether they resided on the coast or in the interior, although as previously mentioned, those cultures, no matter where they lived, were more terrestrial than maritime oriented. Some aspects of the Late Prehistoric Eskimos and Thule cultures are generally similar, such as using semi-subterranean houses and making arrowheads and other tools out of antler. However, the differences, namely few ivory implements and check-stamped pottery rather the curvilinear pottery in the Late Prehistoric Eskimos tool assemblage, outweigh the similarities to the extent that the Late Prehistoric Eskimos seem to be a different people than the Thule.

Late Prehistoric Eskimos are known from a number of sites in the southern NPR-A such as Tukuto, Etivluk, and Swayback lakes and in the Nigu and Kuna river drainages (Hall 1976, Irving 1964, Kunz 2002 and 2003).

Nunamiut Eskimo (400 years ago to modern)

The Nunamiut Eskimo first appear in Arctic Alaska's archaeological record about 400 years ago (Kunz 1977, Kunz and Phippen 1988). The appearance of the Nunamiut is probably the result of a direct and rapid evolution out of the Late Prehistoric Eskimo that occurred as the result of the introduction of new technology: dog traction (Sheppard 2004). While dogs are known to have been domesticated and used by Arctic residents for thousands of years (Leonard et al. 2002), until roughly 400 years ago their role in northern Alaska appears to have been as a beast of burden, companion, and perhaps as an aid in the hunt. Archaeological evidence suggests that about 400 years ago dogs were hitched to a sled for the first time in Arctic Alaska. This event had a dramatic effect on the residents of the region because it exponentially increased their mobility so that people could make use of subsistence resources in a larger area, and thus had more options available to them. This single circumstance is probably responsible for the abrupt change that is seen in the lifestyle of the inhabitants of interior Arctic Alaska about 400 years ago (Hall 1978, Sheppard 2004).

For the previous 4,000 years, the inhabitants of Arctic Alaska's interior appear to have spent the winter months living in semi-subterranean houses located on the shores of large lakes. The lakes that were chosen for this purpose were located near reliable fall caribou concentrations so that a large supply of meat could be obtained and set aside for the winter. The lakes chosen also had good fish resources so that if the fall caribou numbers were meager or when the cached meat reserves were exhausted, fish could be utilized as the primary food source (Gerlach and Hall 1988). This system had been developed in large part because of the limited mobility of the people. On foot, it was not easy or practical for hunters to venture very far afield or households to change locations if resources ran out during the winter. Dog traction changed all that. Almost overnight people began to abandon lakeside, semi-subterranean houses and begin living in surface structures such as sod or moss houses constructed in willow patches along stream drainages. This made the resources of the riparian zone, wood for fuel and construction and stone for tool making, easily accessible to them, while the sled and dogs allowed them to travel extensively to exploit a variety of subsistence resources previously not readily available to them. However, because moss/sod houses degrade rapidly, the most easily recognized and commonly found type of Nunamiut archaeological sites are those comprised of rings stones that were used to weigh-down the edges of caribou skin tents. These sites are often found situated on elevated, well-drained ground adjacent to a stream and a substantial willow patch. Such sites are common throughout the southern portion of the NPR-A where rock is available. Undoubtedly, tents were used throughout the region, but, because the edges were held down by blocks of sod, sand, or snow, there is no visible evidence.

The introduction of dog traction among the coastal Eskimos had a similar but less dramatic effect due to their lifestyle. They were more oriented toward marine resources, which, along with the use of watercraft, reduced their need for overland mobility to some degree although dogs and sleds improved their ability to travel across sea ice. Although they did occasionally construct sod houses along stream courses, they also continued to live in semi-subterranean houses until contact with Euro-American whalers, about 1860. Afterwards, most houses along the coast, where driftwood was plentiful, were constructed as surface dwellings.

Even though the Eskimo were not among the first residents in Arctic Alaska, after they first appeared in the archaeological record, their use of the area is unbroken (Reanier 1997, Sheehan 1997). Their technological sophistication enabled them to exploit both coastal and interior ecosystems and they soon became dominant and more numerous than any of the groups that had previously inhabited the region.

While the mid-18th century marked the beginning of the historic period in Alaska, because of its geographical proximity to the Old World, some north Alaskan archaeological sites that predate Columbus' discovery of the New World contain materials manufactured in Europe or Asia (McCartney 1988, Kunz et al. 2005). This circumstance is unique to Alaska, and the most prominent of these sites is located in the Arctic Mountains of the NPR-A.

Some of the later history also played out in this region as the result of contact with the Euro-American arctic whaling fleet beginning about 1850. This resulted in more than 50 years of continuous contact that altered the traditional culture, and set in motion a significant change in Native Alaskan lifestyle (Brower 1942, Foote 1964, Bockstoce 1978).

In just a few generations, the indigenous people of the Arctic Alaska moved from the Stone Age to the Atomic Age.

Table 3-24. Prehistoric cultures of the NPR-A

Cultural tradition/age	Environment/subsistence	Artifacts/tools
Paleoindian Mesa and Sluiceway Complexes, Raven Bluff Assemblage 13,700–11,800 years ago	Land bridge connects Siberia and Alaska; drier and cooler than now; grassland, steppe prairie—mammoth, bison, muskox, caribou, moose, lion, short-faced bear	Bifacial, edge-ground fluted and unfluted lanceolate projectile points; bifacial knives; multi-spurred gravers; microblades w/Raven Bluff?
American Paleoarctic 10,300–7,500 years ago	Climate becomes warmer and wetter; tundra replaces grass; land bridge subsides; mammoth and bison gone	Microblade technology; burins; bifacial projectile points and knives
Northern Archaic 7,500–3,000 years ago	Annual temperatures similar or a bit warmer than 20th century average; dependence on big game primarily caribou, no evidence of marine exploitation	Microblade technology; notched and stemmed bifacial projectile points and knives; large scrapers
Denbigh Flint Complex 5,000–2,400 years ago (beginning of Eskimo cultural tradition)	Climate cooled slightly, drier than preceding period; caribou is primary subsistence animal; first evidence of sea mammal hunting; orientation more toward terrestrial than marine resources	Microblade technology; burins; diminutive side and end blades; flake knives; discoids; composite tools; semi-subterranean houses
Choris 3,800–2,200 years ago	Climate same as during the Denbigh Flint Complex period; caribou is primary subsistence animal, but there is increased emphasis on the hunting of sea mammals, primarily seals; most known sites are coastal; orientation slightly more toward terrestrial than marine resources	Burins; large bifacial projectile points; pottery; ground stone; bone, antler and ivory implements; semi-subterranean houses
Norton 2,600–1,800 years ago	Climate same as during the Denbigh Flint Complex period; caribou is primary subsistence animal, although seal hunting is an important aspect of the economy; generally more oriented toward terrestrial than marine resources.	Pentagonal projectile points; end and side blades; flake knives; discoids; ground stone; pottery; composite tools; antler, bone and ivory implements; semi-subterranean houses
Ipiutak 1,800–1,200 years ago	Climate slightly warmer and wetter than preceding 3,000 years; marine and terrestrial resources equally exploited; more emphasis on sea mammal hunting than previously	End and side blades; flake knives; discoids; no pottery or ground stone; composite tools; intricate ornamental ivory carvings; burials; semi-subterranean houses
Birnirk 1,600–1,000 years ago	Climate same as during Ipiutak period; coastal resources exploited more than terrestrial; more emphasis on sea mammal hunting than previously; watercraft based open water whaling begins	End and side blades; ground slate tools; ivory and antler harpoon heads; composite tools; pottery; semi-subterranean houses
Thule 1,000–400 years ago	The climate cools about the middle of this period; almost exclusively a marine orientation; whaling technology at its prehistoric peak; caribou remains an important part of subsistence economy	End and side blades; ground slate tools; ivory and antler harpoon heads; composite tools; dragfloat; pottery, semi-subterranean houses

Table 3-24. Prehistoric cultures of the NPR-A

Cultural tradition/age	Environment/subsistence	Artifacts/tools
Late Prehistoric Eskimo 700–400 years ago	During most of this period the average annual temperature is cooler than previous 1,000 years; primarily a terrestrial subsistence economy centered around caribou; some exploitation of coastal ecosystem	End and side blades; long-stemmed projectile points; pottery, bone, antler, ivory implements; ground stone, semi-subterranean houses
Nunamiut 400 years ago–Historic	Warming begins about 150 years ago; exploitation of inland ecosystem centered on caribou; dramatic shift in aspects of subsistence economy after Euro-American contact about 125 years ago	Bifacial stone projectile points; bone and antler projectile points; metal projectile points; firearms; sod houses; Euro-American items after 1875

3.4.2.2 Cultural Resource Sites

The NPR-A is extremely remote and isolated, although due to technological advances in aircraft and ground vehicles over the last 50 years, the area has become more accessible. While some very limited cultural resource data were collected during the initial petroleum reconnaissance activities of the late 1940s and early 1950s (Solecki 1951), no planned data collection surveys were undertaken until the 105c studies of the late 1970s, when the management of what was then known as Naval Petroleum Reserve Number Four was transferred to the Interior Department and renamed the National Petroleum Reserve-Alaska (Davis et al. 1981, Hall and Gal 1988). The 105c archaeological surveys in the NPR-A, conducted by the National Park Service, concentrated on just a few specific areas and inventoried less than 1 percent of the land within the area. Nonetheless, more than 600 sites were located. In the years that followed the 105c work, as funds have been available, the Bureau of Land Management has engaged in systematic cultural resource reconnaissance of the NPR-A. As a result, more than 500 additional sites have been located although less than 3 percent of the total surface area of the NPR-A has been surveyed. To date most inventories and surveys have been conducted in major stream drainages where sites are expected to occur and this phase of the work is not yet completed. Additionally, few of the secondary drainages have been examined which suggests that there are a tremendous number of as yet undiscovered cultural resource locales in the NPR-A, and that examination of the unsurveyed portions of the Reserve would dramatically increase the number of known sites. Known sites include evidence of a variety of prehistoric seasonal camp locations, trading locales, fishing and hunting camps, hunting lookouts, and village sites. Native historic sites, such as sod house over-wintering locales and tent-ring, wolf pupping camps, are present, as well as locales of late 19th century Euro-American discovery expeditions and early oil and gas exploration activities.

The Alaska Heritage Resources Survey data base, which is maintained by the State of Alaska, Department of Natural Resources, Office of History and Archaeology, shows more than 1,500 site entries for the NPR-A. However, that number includes non-cultural paleontological sites as well as sites listed on the North Slope Borough's Traditional Land Use Inventory, many of which are place name locales rather than physical remains. Approximately 850 of the sites listed on the Alaska Heritage Resource Survey in the NPR-A are cultural sites (Alaska Heritage Resources Survey 2011).

Three physiographic provinces are found in the NPR-A: the Arctic Coastal Plain, the Arctic Foothills, and the Arctic Mountains (see Map 3.2.4-1). These provinces are determined primarily by geomorphology and landscape which together create a sort of macro-habitat. In this case, habitat is viewed as a specific assemblage of natural resources available to the prehistoric human population of the region to sustain life. The ability of a physiographic province to support human life is represented by the density (number) of cultural sites on the landscape through time.

The Arctic Coastal Plain needs to be divided into two sections: first, the coast and a 10-mile wide strip of land that borders it, and second, the Coastal Plain. The modern coast (sea level) was not established until about 6,000 years ago and archaeological evidence suggests that there was no significant use of the coast until about 5,000 years ago (Kunz and Adkins 2007). Following that time there has been continual use of the coastal environment by Alaska Natives and since about 1850 AD by Euro-Americans. Along the coast, sea mammals and caribou have usually been available in numbers significant enough to be considered reliable subsistence resources and abundant driftwood was available for construction material and fuel. As a result, the coast has supported a fluctuating but continuous human population. As does any region north of the course of the Colville River, the coast lacked the tool stone (chert) needed to make chipped stone implements and long distance forays or trading was required to obtain it. In terms of cultural site density, the coast would rank second among the physiographic provinces. The remainder of this province, the interior Coastal Plain, is known for its paucity of prehistoric sites although the entire 13,700 years of regional human chronology is represented. The geomorphology is predominately Pleistocene-age dunes stabilized by tundra vegetation, pingos, numerous lakes, and meandering streams with elevations below 350 feet above sea level. Terrestrial subsistence resources in the region are seasonal, and generally speaking, most groups that used the area probably did so in the warmer months choosing to overwinter on the coast or the Arctic Foothills where subsistence resources were more reliable. This pattern of use probably changed to some degree after dog traction became available as it provided the wherewithal for rapid, long-distance transportation.

Like the Coastal Plain, the Arctic Foothills can be divided into two sections. The section north of the Colville River consists of east-west trending ridges and mesa-like uplands. Elevations are generally less than 1,600 feet above sea level. The northern section and much of the southern section was unaffected by the Pleistocene Brooks Range glaciations which had been in retreat for several thousand years by the time the first people arrived. Prehistoric sites in this area cover the entire span of human occupation of the Arctic, but site density drops off rapidly moving north away from the Colville. This decrease in site density mirrors the decrease in resources that occurs moving north. The geomorphology of the southern section is much the same as the north, but with elevations to 1,900 feet above sea level as the hills rise into the Brooks Range. Prehistoric site density increases south toward the Brooks Range as the available resources increase. The southern portion of the Foothills Province and the Arctic Mountain Province contain the highest prehistoric site density in the NPR-A. The number of recorded cultural sites in this region in terms of the area surveyed, is more than several times greater than the combined number of sites in the rest of the NPR-A. The reason for this is primarily a geophysical one. The varied geomorphology (landscape) of the region, mountains, foothills, alpine tundra, moist/wet tundra, ridges, bedrock outcrops, glacial features, large lakes and numerous streams of various magnitudes, provides an array of resources not available in the areas previously discussed. Because of the variety of vegetation and habitats there is and was a greater number and diversity of terrestrial mammals, which provided food, clothing, and other materials so important to prehistoric peoples. Chert, the rock type that is the primary material from which stone tools are made, is ubiquitous. The depositional glacial features which are absent in the rest of the NPR-A, such as kames, kame terraces, eskers, and moraines, provide excellent, well-drained camping locations and sources of tool stone, as do the many stream-side terraces. These terraces and glacial features along with the bedrock ridge systems provide excellent routes for pedestrian travelers. The riparian habitat along the streams supports numerous stands of willow, the only readily available wood for use in construction or as fuel. With the exception of the Awuna River, all the major drainages that feed the Colville River head on the Continental Divide along the north face of the Brooks Range. Many of these drainages have what might be termed a reciprocal drainage on the Divide's south slope that feed the Noatak and Koyukuk drainages. Often these north and south flowing streams head in an accessible pass less than 0.25 mile apart and provide a pedestrian connection between major drainages and the vast areas that are their watersheds. While the abundant natural resources of this region made it extremely attractive to prehistoric residents of the NPR-A, the fact that it also provided travel routes through the Brooks Range linking the Bering Strait region, the Arctic Coast and interior Alaska also contributed to the high density of cultural resource sites throughout the area (Burch 1975, 1976).

Most of the cultural sites in the NPR-A are, by virtue of their isolation and remoteness, protected from most types of impacts other than those caused by natural forces. The vast majority of the prehistoric sites are partially exposed, or at most shallowly buried, and are therefore vulnerable to impacts generated by human activity. Historic sites, (including Distant Early Warning-Line and oil and gas exploration locales older than 50 years) almost without exception, lie on the surface and are extremely susceptible to impacts. Although most surface-disturbing activities such as oil and gas exploration and overland freighting take place during the winter when snow covers the deeply frozen ground, damage to or destruction of cultural sites can occur. For this reason, foreknowledge of planned surface-disturbing activities, whether planned to occur in winter or summer, is essential if these resources are to be protected as directed by law, Executive Order, and policy.

It is noteworthy that only rarely does a single cultural group hold sway over a region as large as Arctic Alaska for such an extended period of time. The modern indigenous population of Arctic Alaska is as successful today, subsisting in one of the harshest environments on the planet, as were their ancestors of 5,000 years ago. The hard evidence that supports this story, the material culture of Arctic Alaska, resides in the prehistoric and historic sites distributed throughout the region. These sites contain the physical manifestation of the culture history of Arctic Alaska. It is a nonrenewable resource, and thus must be protected and managed wisely for both its cultural and scientific values.

3.4.2.3 Cultural Resources and Climate Change

There is little doubt that climate change will cause alterations to the environment and habitats of the North Slope that could adversely affect cultural resources (Scenarios Network for Alaska Planning 2010, Mann et al. 2010) although the degree to which this might happen remains unclear. Past episodes of climate fluctuation in Arctic Alaska have caused changes in vegetation coverage and type as well as the physical structure of the landscape itself (Mann et al. 2010). Both the deepening of the active layer and the thawing of near-surface permanently frozen ground have, during episodes of past warming, initiated mass down-slope movement resulting in the erosion of hillsides, bluff faces, river banks and terraces (Mann et al. 2010), which could result in partial or total the destruction of cultural sites located on those land forms. The real culprit in these cases is the increase in moisture, which greatly exacerbates the circumstances. In addition, even when erosion does not occur, the deepening of the active layer and/or thawing of permanently frozen ground could result in decreased preservation of subsurface organic cultural materials. It should be noted, however, that in less dynamic circumstances erosion has exposed many of the known cultural deposits in the NPR-A, particularly in areas with little or no organic soil and sparse vegetation. In most cases, this type of limited natural impact is viewed as positive rather than negative, as it reveals the presence of sites and usually generates few negative results.

Climate change will also cause the alteration of weather patterns and an increase in the frequency and intensity of spring and fall storms. Coupled with warming, storm surges are intensifying shoreline erosion along the Beaufort and Chukchi coastlines and in the barrier islands and have likely impacted or destroyed a large number of unrecorded sites. A good example of this can be seen at the village site of Kolovik on the Beaufort Sea coast about 90 miles east of Point Barrow. The village was occupied from about 1890 until the late 1940s. At the time of its abandonment two whale boats were left drawn up on the shore about 150 feet from the high tide line. In the late 1970s, these boats were about 120 feet from the water. This site was monitored irregularly since the late 1970s and at the turn of this century, it was noted that the rate of shore erosion was accelerating. In 2003, a survey of the site was made and at that time, the distance of the whale boat nearest the wash zone was 100 feet. In 2007, as the result of shore erosion, the boat was overhanging the water. In less than 4 years 100 feet of shoreline had been lost compared to the loss of about 50 feet over the preceding 56 years. By the summer of 2008, the boat was gone and the erosion continues.

As a result of a decrease in seasonal ice cover, increased maritime activity along the coastal areas, in waterways, and in lakes could result in the initiation of erosion due to boat wakes, possibly exposing and impacting coastal and riverine cultural resources. However, in most of the NPR-A, boat-wake erosion will not be an issue.

It should be remembered that these potential climate change impacts will not be universal across Arctic Alaska. There are a myriad of factors involved that control the degree to which climate change can effect a specific location, region, habitat or ecosystem. Some locales may not be affected at all (Mann et al. 2010).

3.4.3 Subsistence

For Alaska Natives, the continued viability of the subsistence way of life is of the greatest importance. Subsistence hunting and other features of the subsistence way of life embody cultural, social, and spiritual values, constituting the essence of Alaska Native culture (Bryner 1995, Alaska Department of Natural Resources 1997). For the North Slope and northwest Alaska Iñupiat who comprise the primary subsistence users of the planning area, subsistence resources are nutritionally critical because they constitute a mainstay of the diet and are commonly fresher and healthier than store-bought food. They are also economically critical and can be viewed as import substitution because, due to high transportation costs and relatively small market sizes, food costs in northern Alaska communities are much higher than in Alaska's major urban population centers. Subsistence systems, therefore, provide food security and can be classified as economic systems, but they are also important social and cultural systems (Okada 2010).

Because subsistence encompasses all phases of harvesting, processing, sharing, and consumption of food, it is inextricably intertwined with social interactions and cannot be separated from other aspects of Alaska Native life. Subsistence resources are highly valued and central to Iñupiaq customs and traditions, which encompass sharing and distribution networks, cooperative hunting, fishing, and ceremonial activities. The importance of having experienced hunters teach hunting practices to younger generations, for example, is a critical element in the growth and identity of young men (Hess 2010). Kruse (1986) found that young men participated in major subsistence activities as much as the older generation, and those who had been exposed to Western influences through outside schooling tended to be more interested in subsistence. Subsistence hunting is also increasingly recognized as a method of deterring young men from alcohol and drug abuse (Hess 2010). Subsistence is the connection that the Iñupiat have with their past and with the land, weather, and resources of the planning area. About 87 percent of North Slope Borough and 91 percent of Northwest Arctic Borough residents are satisfied with the amount of fish and game that is available in their region. Tim Towarek, Chairman of Alaska's Federal Subsistence Board, stated that "subsistence is not just a way of life, it is life itself," (Alaska Federation of Natives 2010).

Subsistence as it occurs on the North Slope is also a dynamic system, which includes an important cultural value system of sharing as a major form of distribution (Okada 2010). People share within kinship networks, outside of their families, and with other communities. In the North Slope Borough, 92 percent of households receive subsistence food from others, 51 percent exchange traditional foods, and 62 percent receive food in exchange for assisting others (Poppel et al. 2007). The tradition of sharing is firmly a part of Iñupiaq culture that occurs all across the North Slope; it has lasted for as long as people can remember, and it is a tradition that no one wants to see disappear (Poppel et al. 2007).

Subsistence fishing and hunting are important sources of nutrition in almost all rural communities. The Alaska Department of Fish and Game (2010) estimates that the annual wild food harvest in the Arctic area of Alaska is approximately 10,592,409 pounds, or 436 pounds per person per year. Subsistence harvest levels vary among communities (Alaska Department of Fish and Game 2010) and consumption levels of subsistence foods vary within communities, but the levels are significant. The Alaska Department of Fish and Game 2010 overview reports that 63 percent of households harvest game, 92 percent use game, 78 percent harvest fish, and 96 percent use fish. When North Slope households were surveyed in 1999 to determine how much of their overall diet was made up of subsistence food, 78.5 percent of Nuiqsut households reported that half or more of their food was from subsistence (USDOI Minerals Management Service 2008). The Survey of Arctic Living Conditions found that in 57 percent of households in Barrow and in 72 percent of households in the smaller communities,subsistence meat and fish constitute half or more of the meat and fish consumed (Poppel et al. 2007). The traditional subsistence diet of Alaska Natives is also nutritious and protective against the development of cancer, heart disease, diabetes, and other metabolic disorders (Boyer et al. 2007).

Subsistence is part of a rural economic system that is referred to as a "mixed subsistence-market economy," wherein families invest money into small-scale, efficient technologies to harvest wild foods (Alaska Department of Fish and Game 2000). Domestic family groups, which have invested in gill nets, motorized skiffs, and snowmachines, conduct these important activities. Subsistence is not oriented towards sales, profits, or capital accumulation (commercial market production), but is focused toward meeting the self-limiting needs of families and small communities. Fishing and hunting for subsistence provide a reliable economic base for many rural regions that has existed alongside a wage economy on the North Slope as far back as the period of commercial whaling (VanStone 1960). North Slope communities continue to place a high value on their ability to engage in both the wage economy and subsistence way of life (Wolfe and Walker 1987). A 1988 study found that men working full-time jobs engaged in slightly more subsistence activities than those with less than full-time work (Kruse 1991b). As one North Slope hunter observed: "The best mix is half and half. If it was all subsistence, then we would have no money for snowmachines and ammunition. If it was all work, we would have no Native foods. Both work well together" (Alaska Consultants, Inc. et al. 1984). The 2010 Alaska Department of Fish and Game Update on Subsistence in Alaska estimated that at a replacement value of $3.50 per pound, the average amount of wild food harvested per person in the Arctic is worth $37,073,432 ($74,146,863 at $7 per pound).

Full-time, year-round wage employment has positively and negatively affected the pursuit of subsistence resources. It has positively affected the subsistence hunt by providing cash for snowmachines, boats, motors, fuel, equipment, and ammunition required for the hunt. Full-time year-round employment limits the time a subsistence hunter can spend hunting to after work hours. Employment in the oil fields or away from the communities further limits the pursuit of subsistence resources, as the primary hunters may be away working at the best times for harvesting certain resources. During midwinter, this time window is further limited by waning daylight. In summer, extensive hunting and fishing activities can be pursued after work without any light limitation, but travel is limited to raised ground and waterways because of the difficultly in traveling on wet tundra.

3.4.3.1 Federal Subsistence Management

The planning area is comprised of federal land managed by the BLM. Therefore, federal management of subsistence hunting in the planning area is ruled by Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA), which defines subsistence uses as:

> The customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of inedible byproducts of fish and wildlife resources taken for personal or family consumption; and for customary trade (16 USC § 3113).

Title VIII of Alaska National Interest Lands Conservation Act (ANILCA) also establishes both a conservation mandate (a responsibility to conserve healthy populations) and an allocation mandate for subsistence on public lands in Alaska. Federal law, therefore, grants rural subsistence users a priority over others users (such as commercial or recreational use) only when it is necessary to restrict the taking of fish or wildlife in order to protect the viability of such populations or to continue subsistence uses. These mandates are implemented through the Federal Subsistence Program, which is comprised of the Federal Subsistence Board, 10 Regional Advisory Councils, and interagency staff specialists.

The Federal Subsistence Board consists of the regional or state directors for the U.S. Fish and Wildlife Service, Bureau of Land Management, Forest Service, National Park Service, and Bureau of Indian Affairs, and is chaired by a subsistence user representative appointed by the Secretary of the Interior. The Federal Subsistence Board is tasked with management of subsistence resources on public lands relative to population health and maintenance, including setting bag limits, seasons of harvest, means of taking, regulatory and public processes, and providing a rural priority.

Alaska's federal subsistence regulations only apply to federal public land and a person must be a rural Alaskan resident to harvest fish and wildlife under federal regulations. All communities and areas within the planning area are designated as rural; therefore, all permanent full-time residents of the NPR-A are eligible subsistence harvesters (seasonal rural residency does not qualify a person as a rural resident).

The Federal Subsistence Board also determines which communities and areas have customarily and traditionally taken specific fish and wildlife populations. These customary and traditional use determinations are listed along with seasons and harvest limits for each management unit in the federal regulations. If there is a positive determination for specific communities or areas, only those communities and areas have a federal subsistence priority for that particular species in that management unit. If no customary or traditional use determination for wildlife/fish population in a management unit has been made by the Federal Subsistence Board, then all rural residents of Alaska may harvest fish or wildlife from that population. The Federal Subsistence Board may determine that there is no customary and traditional use of a specific fish or wildlife population. This means there is no federal subsistence priority and, therefore, no federal subsistence seasons or bag limits for that area and population.

3.4.3.2 Subsistence Use of the NPR-A

The planning area has within its borders four federal qualified subsistence communities: Barrow, Wainwright, Atqasuk, and Nuiqsut. Several other federal qualified subsistence communities are considered in this IAP/EIS because they depend on resources from the NPR-A. The North Slope Borough communities of Point Lay and Anaktuvuk Pass are given equal consideration as those within the planning area because they are intensive users of the NPR-A. For many other communities, the planning area effectively comprises the periphery of their traditional harvest areas for terrestrial resources that are available during the winter months, when long-distance overland travel is possible by snowmachine. The planning area comprises the outer limit of traditional furbearer and small mammal harvesting for the communities of Ambler, Kiana, Noatak, Shungnak, and, to a lesser extent, Kobuk, Selawik, and Noorvik.

The BLM is responsible for administering the Federal Subsistence Program on BLM public lands in the planning area, including data collection and analysis, and implementing and enforcing regulations. The overall objective is to provide for rural subsistence use, while maintaining healthy populations of subsistence resources within the bounds of recognized fish and wildlife management principles.

Community Subsistence Harvest Patterns

Subsistence resources are often harvested while staying at specific camps where multiple resource harvest opportunities are available in each season. Generally, communities harvest resources nearest to them, but harvest activities may occur anywhere in the planning area. Harvests tend to be concentrated near communities, along rivers, and the coastline at particularly productive sites. The distribution, migration, and the seasonal and more extended cyclical variation of animal populations make determining what, where, and when a subsistence resource will be harvested a complex activity. Areas might be used infrequently, but they can be quite important harvest areas when they are used (USDOI BLM 1978e).

Species use and harvest success can vary greatly over short periods of time, and short-term harvest data analyses can be misinterpreted as a result. For example, if a particular community did not harvest any bowhead whales in one year, community use of caribou and other species would increase to compensate for the loss of that resource harvest. If caribou are not available in the winter, other marine and terrestrials species would be hunted with greater intensity. Scenarios such as this have taken place in Kaktovik and Nuiqsut in the last 25 years (Brower and Hepa 1998). For example, in 1992 the percentage of the three primary resource categories harvested by Nuiqsut was relatively equal, with terrestrial mammals comprising 27.6 percent, marine mammals 35.1 percent, and fish 34.6 percent (Fuller and George 1997). However, during the harvest-recording period of July 1994 to June 1995, marine mammals in Nuiqsut comprised only 2 percent of the total harvest, with terrestrial mammals increasing to 69 percent of the total harvest (Brower and Opie 1997). This increase in harvest of terrestrial mammals, primarily caribou and moose, was the result of the community failing to land a whale during the 1994 season. In cases such as this, the cultural value of sharing and reciprocity ensures that other communities will contribute subsistence foods to the communities affected. In some cases, communities have sponsored hunts in their vicinity for communities suffering a harvest failure. Anaktuvuk Pass and Nuiqsut have recently participated in such an exchange (Steven R. Braund and Associates 2003a). However, even when sharing and reciprocity are able to meet the dietary need for subsistence foods, the cultural significance of a failed hunt can be quite significant. For example, Rosemary Ahtuangaruak of Nuiqsut said:

> We had seismic activity in Camden Bay that caused us to lose two whaling boats. We did not harvest whale two seasons in a row. We went without whale those winters. Those were the deepest, darkest winters I faced as a community health aide. We saw an increase to the social ills, we saw domestic violence, we saw drug and alcohol abuse, we saw all the bad things that come when we are not able to maintain our traditional activities (USDOI BLM 2004d).

While subsistence resource harvests differ between communities, the resource combination of bowhead whales, caribou, and fish are the main subsistence resources for Barrow, Nuiqsut, Wainwright, and Atqasuk. The bowhead whale is the preferred meat and the subsistence resources of primary importance because it provides a unique and powerful cultural basis for sharing and community cooperation (Stoker 1983). Point Lay has relied more heavily on beluga whales than other communities and only recently successfully hunted a bowhead whale after a 72-year hiatus. The dominant subsistence resource in Anaktuvuk Pass is caribou and the community only enjoys marine mammal resources that are shared or traded. Caribou is the most important overall subsistence resource in terms of numbers of animals harvested and consumed, and the greatest frequency of hunting trips taken. Depending on the community, fish is the second or third most important resource after caribou and bowhead whales. Bearded seals and waterfowl are also considered primary subsistence species. Seal meat, oil, and hides are important staples and necessary complements to other subsistence foods. Seal oil, in particular, is desired for use as a condiment. Waterfowl are important during the spring, when they provide the first fresh meat of spring and add variety to the subsistence diet. Migratory birds from the NPR-A are important to Native peoples in western, southwestern, and interior Alaska, and along the Pacific Flyway.

The subsistence pursuit of bowhead whales is of major importance to the communities of Barrow, Wainwright, Nuiqsut, and, now, Point Lay. Several men from Point Lay used to travel to Point Hope, Barrow, and Wainwright to whale until the community of Point Lay won the right to hunt bowhead (a quota of one whale) in 2008. Several men from Atqasuk whale with Barrow or Wainwright crews. The sharing of whale maktaq and meat is important to inland communities. Whaling continues to be the most valued activity in the subsistence economy of these communities, even in light of harvest constraints imposed by International Whaling Commission quotas. Seasonally plentiful supplies of other subsistence resources such as caribou and fish, as well as supplies of retail grocery foods, supplement and support whale harvests. Whaling traditions include kin-based crews, use of skin boats during the spring whaling season, onshore preparations for distribution of the meat, and regional and extra-regional participation and sharing. These traditions remain central values and activities for Iñupiat in these North Slope communities, where 55 percent of residents are members of whaling crews and 68 percent help whaling crews by cooking, giving money or supplies, or cutting meat (Poppel et al. 2007). Bowhead whaling strengthens family and community ties and the sense of a common Iñupiaq heritage, culture, and way of life. In this way, whaling activities provide strength, purpose and unity in the face of rapid change. Until the fall of 2010, Barrow was the only community within the area that harvested whales in both the spring and the fall. The community of Wainwright has traditionally only harvested whales during the spring from the shore-fast sea ice because it was believed that bowhead whales did not travel near enough to be successfully harvested during their fall southward migration (Kassam and Wainwright Traditional Council 2001). However, in the fall of 2010, crews from Wainwright traveling in Lund boats (smaller than the boats used for fall whaling in Barrow) successfully hunted a bowhead whale that they struck approximately 25 miles from the community (about 15 miles offshore). Subsistence whaling for the community of Nuiqsut occurs only during the fall season, although some Nuiqsut hunters travel to Barrow to participate with Barrow whaling crews during the spring whaling season (North Slope Borough 1998).

Traditional Iñupiaq Settlement Patterns

The North Slope Iñupiat have undergone numerous adaptations in response to changing cultural, social, and physical environments. Before sustained contact with Euro-Americans, the Iñupiat moved seasonally between coastal and riverine environments on the arctic coastal plain, gathering at communally recognized locations for seasonal bowhead whale hunts or cooperative hunts using caribou drive lines and subsequent celebrations of successful harvests. If the whale harvest was successful, the meat and maktaq were distributed and a celebration, Nalukataaq, was held. The Iñupiat would again disperse to coastal and riverine winter residences after whaling (Steven R. Braund and Associates and

Institute of Social and Economic Research 1993). Numerous regional groups of Iñupiat and Athabascans gathered at trading fairs, including one in the Nuiqsut area (Elavgak in Brown 1979).

The Iñupiat developed adaptive responses to the variable distribution and availability of subsistence resources, including sociocultural and technological strategies. Sociocultural strategies included an emphasis on sharing and hospitality, nonrestrictive land use rules, wide-ranging mobility to extract sparsely distributed resources, and an adaptive set of hunting rules and techniques. Examples of hunting rules included allowing the lead caribou of a herd to pass so that the main herd is not diverted and taking only as many caribou as necessary. Examples of hunting techniques included the use of caribou drivelines and allu—breathing holes for hunting seals. Technological adaptations included specialized tools for harvesting subsistence species, innovation as new materials were introduced (e.g., steel, plastic, woven fabrics), and a willingness to adopt new technologies from other cultures if there were clear advantages in their use (e.g., rifles, outboard motors, snowmachines) (Brown 1979, Impact Assessment, Inc. 1990a, 1990b).

Euro-American contact began intermittently in the early 19th century and intensified with the shift of commercial whaling north of the Bering Strait in the 1850s. The establishment of a shore-based whaling station at Barrow in 1884 brought Iñupiat from other areas to Barrow in pursuit of wage employment, access to technologically advanced and trade goods, and increased trade opportunities. Eskimo people from as far as Siberia and Saint Lawrence Island moved to Barrow to participate in the commercial whale harvest. After the Pacific Steam Whaling Company ceased shore-based whaling from Barrow in 1896, Iñupiaq whalers took over the shore-based whale harvest, with more affluent captains maintaining as many as six crews year-round (Steven R. Braund and Associates and Institute of Social and Economic Research 1993).

Changes in resource distribution, fluctuation in whale and caribou populations, epidemic disease, and prolonged contact with Euro-Americans caused major changes in the geographic distribution and lifeways of the Iñupiat (Steven R. Braund and Associates and Institute of Social and Economic Research 1993). The eventual depletion of whales and other marine mammals, as well as the increased hunting pressure caused by the need to provision whaling crews, may have caused critical resource shortages. The promise of jobs and access to trade goods in conjunction with famine and disease caused a decline in the overall population of the region and the relocation of inland peoples to the coastal villages. In response to the famine and a need to feed stranded commercial whalers, the federal government instituted reindeer herding programs in Point Hope, Wainwright, and Barrow, which lasted until the 1930s. The Barrow reindeer herd dispersed by 1952 because of inattention, predation by wolves, and assimilation into wild caribou herds.

Commercial whaling ended by 1910, and fur trapping became an alternative method for the Iñupiat to participate in the cash economy. While commercial whaling had brought Iñupiat from inland to the coast, specifically to Barrow and Wainwright, trapping encouraged the Iñupiat to disperse along the coast and return inland to winter trapping camps. The Depression forced fur prices down and made trapping unprofitable for Iñupiaq hunters. Following the Depression, the Iñupiaq population again aggregated into centralized communities following the establishment of schools, missions, and churches, and the enforcement of truancy laws. Economic growth presented opportunities that drew Iñupiat to the growing cities of Fairbanks and Anchorage (Hoffman et al. 1988).

During World War II, the U.S. Navy and other federal agencies began exploring the then PET-4 area, mapping the Beaufort Sea Coast, and establishing research stations near Barrow (Ebbley and Joesting 1943). After the war, Distant Early Warning-Line radar sites provided employment to a number of Iñupiaq people and allowed them to continue to use subsistence resources while providing access to Euro-American goods and services (Hoffman et al. 1988). Wage employment (e.g., PET-4, Naval Arctic Research Laboratory, Federal Aviation Administration, and Weather Bureau) attracted inland and coastal Iñupiat to Barrow (USDOI MMS 1992).

Not all Iñupiat moved to centralized communities. Many continued to move around on the land much as their ancestors had. Iñupiat who had settled in Barrow or Wainwright for access to education and health care returned seasonally to the areas from where they or their families had come. Following the passage of the Alaska Native Claims Settlement Act and the incorporation of the North Slope Borough in the early 1970s, groups that had centralized in Barrow and Wainwright to gain access to education, health care, employment, and other advantages of a more urban life began to return to formerly used subsistence harvest areas. Modern communities were established at Nuiqsut, Atqasuk, and Point Lay and people also returned to Anaktuvuk Pass and Kaktovik.

3.4.3.3 Contemporary Subsistence Uses

Anaktuvuk Pass

Anaktuvuk Pass is located in a high valley of the Brooks Range and the people of the community are known as “Nunamiut,” meaning Inland Iñupiat (nuna: land, miut: from). In the late 1940s, the Nunamiut came together and settled into Anaktuvuk Pass from Chandler Lake, Killik River, and Tuluġaq Lake (Rausch 1951, 1988). The Nunamiut people of Anaktuvuk Pass are among the few in the North Slope Borough without direct access to marine mammals. As a consequence, the Nunamiut rely heavily on terrestrial mammals and fish for subsistence. Caribou is the main terrestrial mammal resource, with moose and Dall sheep also important resources for hunters. Freshwater fish from area lakes and streams are an important supplement to terrestrial mammals. Terrestrial resources are often bartered for marine resources from other communities, particularly Nuiqsut and Barrow (Bacon et al. 2009, Brower and Opie 1996, Fuller and George 1999).

Seasonal Round

Caribou hunting is the mainstay of the Nunamiut subsistence hunt. Caribou are hunted year-round as needed, and heavily from July through November (Table 3-25). The caribou migrate through the Anaktuvuk Pass area twice a year, in the spring and fall, but the number and timing of the caribou migration through the area vary from year to year. Dall sheep, grizzly bear, and moose are hunted in August, September, and October some distance from the village, with Dall sheep the main target. Between November and April, furbearer harvesters travel substantial distances from the community, with peak harvest activity in February or March depending on snow conditions. Birds and fish are supplementary to terrestrial mammals, but are harvested when available and increase in importance if caribou numbers are low. Berries are seasonally important, with salmonberries (*akpik*) and blueberries providing the majority of vegetable foods.

Subsistence Harvests

Terrestrial mammals comprise up to 95 percent of the harvest, with nearly three-fourths of the community participating in the harvest. Caribou are the main terrestrial mammal species harvested, with moose and sheep also harvested in small numbers. Fish are a smaller component of the subsistence diet by weight, but are still an important food source. Fish species harvested include grayling, arctic char, lake trout, burbot, and pike. Birds harvested during the brief migration period include a variety of geese and ducks. Preferred species are white-fronted and Canada geese and several species of small ducks, such as northern pintails. Vegetation harvested includes berries and masu, or "Eskimo potatoes" (Steven R. Braund and Associates 2003a).

Table 3-25. Annual cycle of subsistence activities, Anaktuvuk Pass

Species	Winter					Spring		Summer			Fall	
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Caribou	▒	▒			▒	▒	▒	▒	■	■	▒	▒
Sheep										■	▒	
Moose										■		
Grizzly Bear										■		
Ptarmigan	▒			■	■	■						
Furbearers		▒	▒	■	■							
Fish						▒	▒	▒	■	■	▒	
Berries										■		

	No to very low levels of subsistence activity
▒	Low to medium levels of subsistence activity
■	High levels of subsistence activity

Sources: Brower and Opie (1996) and Steven R. Braund and Associates (2003a).

Subsistence Use Areas

An important factor contributing to the permanent settlement of Anaktuvuk Pass was the seasonal migration of caribou through that area. Map 3.4.3-1 is a partial subsistence use area map for the years 1993–2002 and is based on interviews conducted in 2003 for the Alpine Satellite Development Project Final EIS (Steven R. Braund and Associates 2003a and 2003b, USDOI BLM 2004c). More detailed and exhaustive mapping of lifetime subsistence use areas for the community were presented in the 1985 report produced by Hall et al. (1985) for the North Slope Borough and in the 1998 Northeast IAP/EIS (USDOI BLM and MMS 1998).

Residents used to herd small groups of migrating caribou into lakes, streams, or valleys to limit their mobility and then harvest and process the caribou in a cooperative group undertaking (Spearman 1979). While waiting for the caribou to be herded through these areas, members of the group would fish in the streams and lakes. Nunamiut hunters bartered furs and dried caribou for other resources, such as marine mammal fat and hides, with coastal people at trade fairs in the Colville River Delta, Barrow, and Barter Island. The Nunamiut currently trade resources and hunting access with Nuiqsut people in much the same manner as they have for centuries; however, hunters now use modern means of transportation and hunt on a compressed time schedule (Spearman 1979, Hall et al. 1985 Steven R. Braund and Associates 2003a).

Highest use areas are within 20 miles of Anaktuvuk Pass, with most hunting trips taken in the immediate vicinity of the community (Brower and Opie 1996). Lifetime subsistence use areas, as depicted in Hall et al. (1985), encompass a greater area than the North Slope Borough, spanning from Aklavik in the McKenzie River Delta in Canada's Northwest Territories to Kivalina and Kotzebue Sound and north to Point Barrow and Wainwright. Travel corridors and trapping areas included the Sagavanirktok, Killik, Kobuk, Itkillik, John, and Colville rivers and the coast between the Colville River Delta and Demarcation Point (Hall et al. 1985).

The Nunamiut have used the valleys and slopes of the Brooks Range between the Killik River valley and Itkillik Lake, with some resource users traveling farther east and west on occasion. North of the Brooks Range, resource users traveled by snowmachine and all-terrain vehicle along the front slope of the mountains east to Itkillik Lake, west to Chandler River, north to Rooftop Ridge, and parallel the Colville River past Umiat to the Chandler and Killik Rivers, then heading back south in the mountains.

Periodic shortages of caribou and other game have made living inland difficult for Iñupiaq people for centuries and have required them to follow the migrating caribou herds year-round. One result of sedentary life was the increased difficulty people experienced in harvesting adequate amounts of subsistence foods, even with modern transportation and other equipment. An added and more recent complication was the establishment of the Gates of the Arctic National Park and Preserve, which has restricted the use of certain all-terrain vehicles (such as Argos and four-wheelers) during snow-free times of the year, thereby preventing Nunamiut from accessing subsistence areas that they formerly occupied and used during snow-free months (Hall et al. 1985, Kunz 1989, Steven R. Braund and Associates 2003a).

Several times in the 1970s and 1980s and as recently as 1994 and 1998, Anaktuvuk Pass residents found it necessary to travel great distances to procure enough caribou to feed their community. The North Slope Borough paid for some trips, using charter and float planes to fly hunters from Anaktuvuk Pass to places like Umiat and Schrader Lake (located approximately 60 miles southwest of Kaktovik [Steven R. Braund and Associates 2003b]). More recently, hunters have traveled to Nuiqsut to harvest caribou for Anaktuvuk Pass, and on other occasions, Nuiqsut hunters have provided caribou, fish, and other coastal foods during lean times. The Nunamiut have reciprocated with gifts of dried meat and other Nunamiut specialties.

There is a friendly competition between hunters and communities in the pursuit of wolves, wolverines, and foxes. Several Anaktuvuk Pass hunters have traveled north to Nuiqsut and hunted wolf, wolverine, and caribou en route. One hunter said, "I hunted everything on my trip to Nuiqsut," and described the trip to Nuiqsut as "one camp" away. In other words, he left Anaktuvuk Pass, made camp for one night, and reached Nuiqsut the following day. Other hunters have also described the route and noted several important landmarks and features along the way. One hunter had harvested wolf and wolverine near Ocean Point in 1998. While residents of several communities encounter each other while hunting furbearers, it was often noted that "it is better for them to see your tracks than for you to see theirs," since the tracks of another hunters could mean that the animal being sought had already been taken or run off by the other hunter.

Atqasuk

Atqasuk is located inland from the Arctic Ocean on the Meade River, about 60 miles southwest of Barrow. A traditional hunting and fishing site, coal was mined in the area during World War II and freighted to Barrow. The village existed under the name Meade River for 10 years after the war. The population decreased in the 1960s but, after the incorporation of the North Slope Borough, former residents moved back and reestablished the village under the name Atqasuk in the late 1970s.

The area surrounding Atqasuk is rich in caribou, fish, and waterfowl, and a few hunters access areas of the coast for seals and other marine resources. Atqasuk residents consume a wide variety of marine resources, but only a small portion of those are acquired on coastal hunting trips initiated in Atqasuk; most are acquired on coastal hunting trips initiated in Barrow or Wainwright. As mentioned above, some Atqasuk hunters are members of Barrow whaling crews and return to Atqasuk from successful whale hunts with shares of bowhead. As one resident observed, "We use the ocean all the time, even up here; the fish come from the ocean; the whitefish as well as the salmon migrate up here," (Alaska Consultants, Inc. 1984, Bacon et al. 2009, Steven R. Braund and Associates 2009).

Seasonal Round

Atqasuk subsistence harvests rely on a diversity of seasonally abundant resources that hunters must harvest when available (Figure 3.4.3-2). December and January are generally not productive months for subsistence pursuits because of the winter weather and darkness. Between November and April, furbearer harvesters travel substantial distances from the community to harvest wolves, foxes, and wolverines, with peak harvest activity in February or March (depending on snow conditions). In late February and through March, some residents may begin fishing under the ice on the Meade River, its tributaries, and any lakes that do not freeze completely (Steven R. Braund and Associates 2003a).

Hunters may harvest caribou if they are encountered at this time, and the need to harvest more caribou may increase through March as late fall food supplies are depleted. The harvest of caribou may increase as daylight increases and the weather becomes increasingly moderate. Some residents may travel to Barrow to participate in spring whaling. Beginning in May, hunters pursue migrating birds and caribou. The breakup of river ice and lack of snow in June make travel difficult. After the ice goes out, gill netters harvest fish near the community as the fish move upriver to spawn. The high water on the rivers and lakes of the area in late spring and early summer allows the most extensive boat travel. Later in the summer, the water levels may be too low to allow long-range travel, so community residents plan their travels for late June through July. Subsistence resources are particularly abundant from July through September. Berries are seasonally important. Hunters harvest grizzly bears, moose, squirrels, and migratory birds throughout the summer. By October, migratory birds have left the area, and hunters shift their focus to caribou and fish. In November, hunters attempt to harvest enough caribou for the upcoming winter.

Atqasuk residents harvested caribou primarily within 10 miles of Atqasuk, with the majority harvested between July and December (Hepa et al. 1997). Although the late summer/early fall harvest is the most important, caribou are harvested every month of the year (Table 3-26). Caribou migration patterns and limited access prohibit hunting in the late spring and early summer.

Residents harvested fish between June and November, with the greatest number of fish harvested between August and October. Fall and early winter is the preferred time for fishing, when water levels drop in the Meade River and the water becomes clearer. The most productive season for gillnetting begins in June and runs through to fall and early winter. During the fall, fishing continues under the ice in the Meade River and in nearby lakes (Schneider et al. 1980, Alaska Consultants, Inc. et al. 1984, North Slope Borough 1998).

Table 3-26. Annual cycle of subsistence activities, Atqasuk

Species	Winter					Spring		Summer			Fall	
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Fish	▨							▨				
Birds/Eggs	▨	▨	▨	▨	▨	■	■	▨	▨	▨	▨	▨
Berries							▨	▨	▨	▨		
Grizzly bear							▨	■	■	■	▨	
Moose							▨	■	■	■	▨	
Caribou	■	▨	▨	■	■	■	■	▨	▨	■	■	■
Furbearers	▨	▨	■	■	■	▨						

	No to very low levels of subsistence activity
▨	Low to medium levels of subsistence activity
■	High levels of subsistence activity

Sources: Schneider et al. (1980) and Steven R. Braund and Associates (2003a).

Subsistence Harvests

Atqasuk is similar to Barrow and Nuiqsut in that residents harvest caribou, fish, and birds locally; however, Atqasuk is far more connected to Barrow for marine mammal harvests and membership in whaling crews (Hepa et al. 1997). The village depends highly on terrestrial mammals and on fisheries associated with the Meade River Drainage. During the 1994–1995 harvest year, 57 percent of the harvest by edible pounds consisted of caribou. Fish constituted 37 percent of the harvest, birds 3 percent, marine mammals 2 percent, and plants 1 percent.

Most Atqasuk residents participated in subsistence activities and sharing of subsistence resources. Of interviewed households in 1994–1995, 77 percent of residents attempted to and/or were successful in harvesting subsistence resources (Hepa et al. 1997). Fuller and George (1999) reported a participation rate of 90 percent for the 1992 harvest year; of households that successfully harvested subsistence resources in 1994–1995, 91 percent shared their resources with others and 4 percent did not.

Caribou is the most important resource, by weight, harvested by Atqasuk residents. A subsistence harvest survey conducted by the North Slope Borough Department of Wildlife Management, covering the period from July 1994 to June 1995, noted 187 reported caribou harvested by Atqasuk hunters (Hepa et al. 1997). In a July 1996–June 1997 survey, an estimated 398 caribou were harvested (Bacon et al. 2009). Caribou are hunted by boat and snowmachine and on foot from hunting camps along the Meade, Inaru, Topaguruk, and Chipp river drainages (which are also used for fishing). Furbearer hunting by snowmachine involves considerable travel over a widespread area and is generally incidental to caribou hunting (Schneider et al. 1980, Alaska Consultants, Inc. et al. 1984). Caribou harvest surveys of Atqasuk residents conducted by Alaska Department of Fish and Game Subsistence Division, the Iñupiat Community of the Arctic Slope, and the BLM provide the following community total estimates for four consecutive reporting years: 221 caribou during the 2002–2003 reporting year; 352 in 2003–2004; 207 in 2004–2005; and 174 in 2005–2006 (Braem et al. 2010)

Fish is a preferred food in Atqasuk; respondents indicated that fish is the second most important resource in quantity harvested (Alaska Consultants, Inc. et al. 1984). Summer gillnetting, hook and line, late fall and winter jigging through ice, and winter gillnetting under the ice are the four most common fishing techniques. The more prevalent subsistence fishing activity is catching humpback whitefish and least cisco in gillnets. Also caught are broad whitefish, burbot, grayling, and chum salmon (only in some years), all of which are fished with gillnets, baited hooks, and jigging (Craig 1987). Nets are most commonly set close to the community. Narvaqpak (southeast of Atqasuk) is a popular fishing area (North Slope Borough 1998). Most fishing occurs along the Meade River, only a few miles from the village; however, fish are also pursued in most rivers, streams, and deeper lakes of the region. Fish camps are located on two nearby rivers, the Usuktuk and the Nigisaktuvik, and downstream on the Meade River, near the Okpiksak River (Craig 1987).

Humpback whitefish and least cisco accounted for 96 percent of the summer catch in 1983. The summer gillnet fishery in the Meade and Usuktuk rivers produced a harvest of approximately 8,450 pounds of fish. Adding catches with other gear (angling) and winter catches (1,100 pounds and 2,700 pounds, respectively); the total harvest was approximately 12,250 pounds. The annual per capita catch in 1983 was about 43 pounds, with a total of 231 residents in the village (Craig 1987). A subsistence-harvest survey conducted by the North Slope Borough Department of Wildlife Management, covering the period from July 1994 to June 1995, reported that fish harvested by Atqasuk hunters represented 37 percent of the total subsistence harvest in edible pounds (Hepa et al. 1997).

The subsistence harvest survey conducted by the North Slope Borough Department of Wildlife Management reported that bird harvests by Atqasuk hunters represented 3 percent of the total subsistence harvest in edible pounds (Hepa et al. 1997). Subsistence hunters from Atqasuk harvested 279 birds in May, 8 seals in July, and 84 gallons of berries between July and September. Other subsistence foods may be received as shares and traded or bartered within the community and with other villages. Between October and May, fur hunters harvested 2 wolves, 6 ground squirrels, and 10 wolverines.

Subsistence Use Areas

Subsistence hunters from Atqasuk use harvest locations relatively close to the community, with some use of the coast west of Barrow and west of Dease Inlet (Schneider 1980, Hepa et al. 1997). The main advantages of Atqasuk's location are access to the river and lake resources as well as a position in the migration path of the Teshekpuk Lake caribou herd (Schneider 1980). Atqasuk's lifetime subsistence use area, as described in the 1970s and depicted in Map 3.4.3-2, extends from northeast of Wainwright to Barrow, along the coast to the vicinity of Smith Bay, south along the Ikpikpuk River to the Titaluk River, and west and north to Peard Bay (Pedersen 1979).

Based on Steven R. Braund and Associates interviews of subsistence users in Atqasuk, the community's use area has expanded in the past decade. The recent use area extends to the east to the eastern edge of Teshekpuk Lake, to the Kaolak River to the west, to the Inaru River to the north, and beyond the Colville to the south (Map 3.4.3-3). Several Atqasuk residents have ties to the Smith Bay-Cape Halkett-Kogru River areas, and some of these residents used the area north and southeast of Teshekpuk Lake intensively in their youth. One hunter stated that there were "numerous small camps and villages along the coast between Drew Point, Smith Bay, and Dease Inlet. It was a [caribou] grazing area," (Steven R. Braund and Associates 2003a). He explained that there were many ice cellars in an area between the mouth of the Ikpikpuk River and Teshekpuk Lake, named Shubjat, because it was high, dry ground away from the coast. Polar bears, with their keen sense of smell, would find and dig up coastal ice cellars.

Atqasuk hunters travel east as far as Fish and Judy creeks. Resources sought in the eastern portion of the current Atqasuk use area include fish, wolf, wolverine, and caribou. The harvest of caribou in this eastern area, which is incidental to the pursuit of wolves and wolverines, takes Atqasuk hunters far from the community on several extended trips each winter. Atqasuk hunters encounter furbearer and caribou hunters from other communities on these extensive travels. The Kailikpik and Kogru river area and the Fish and Judy creeks area are occasionally used in the winter by Atqasuk hunters traveling by snowmachine, primarily in search of wolf and wolverine. The Kalikpik and Kogru river area is a homeland for several Atqasuk families, who in the past traveled by boat and harvested caribou, birds, and fish in the area.

During the summer and fall, subsistence user areas for caribou, fish, waterfowl, and berries are primarily centered on Atqasuk, generally within 50 miles of the community. The harvest of resources near Atqasuk, both in the summer and winter, consists of day trips involving snowmachines, all-terrain vehicles, and boats, dependent on the season. However, one subsistence user said he would go to one harvest area for a week, and then he would go home for a week or two, gas up, and go to another harvest area (Steven R. Braund and Associates 2003a).

It is not uncommon for winter hunters on snowmachines to encounter hunters from other communities. One Atqasuk hunter, who took several long winter hunting trips, said that he does not go to the area above Umiat, instead leaving "that country to those guys in Nuiqsut. They come up and hunt all over that area in moose season." Hunters make use of camps and cabins belonging to hunters, often relatives, from other communities to support their hunting trips. Atqasuk hunters do not hunt regularly in the Nuiqsut or Colville River areas, traveling to Nuiqsut only for special occasions, such as funerals.

Barrow

Barrow, the economic, transportation, and administrative center for the North Slope Borough, is situated on a point of land which is the northernmost in the U.S. and which is the demarcation point between the Chukchi and Beaufort seas. The community is traditionally known as "Ukpeagvik," meaning "place where snowy owls are hunted." The main subsistence focus in Barrow has been marine mammal hunting, and bowhead whaling in particular. Bowhead whale hunting is the key activity in the organization of social relations in the community and represents one of the greatest concentrations of effort, money, group symbolism, and significance (Steven R. Braund and Associates and Institute of Social and Economic Research 1993). Sixty-three percent of Barrow residents are members of whaling crews (Poppel et al. 2007). Other harvested resources, such as caribou, waterfowl, and several varieties of fish, are vital for subsistence and available to residents, but have less influence on the organization of social relations (Bacon et al. 2009, Steven R. Braund and Associates 2009).

Seasonal Round

Barrow's seasonal round is related to the timing of subsistence resources (Table 3-27). Preparation for bowhead whaling occurs year-round. Spring bowhead hunting is undertaken by Barrow whalers during April and May, with May generally being the most successful month (Steven R. Braund and Associates and Institute of Social and Economic Research 1993). Traditionally, whaling crew members opportunistically hunted other marine mammals, such as seals and polar bears, following spring whaling. Beginning with the whaling season of 1978, bowhead whale quotas instituted by the International Whaling Commission altered traditional spring whaling activities by reducing the opportunity for harvesting bowheads and limiting the pursuit of other marine mammals so as not to jeopardize the bowhead whale hunt. Waterfowl are hunted during the spring whaling season when their flights follow the open leads, providing a source of fresh meat for whaling camps. Later in the spring, Barrow residents harvest many geese and ducks; the harvest peaks in May and early June and continues through the end of June.

Beluga whales are available from the beginning of the spring whaling season through June, and occasionally into July and August, in ice-free waters. Barrow hunters do not like to hunt beluga whales during the bowhead whale hunt for fear of scaring away the larger animals. Thus, the hunters harvest beluga whales after the spring bowhead whale season ends, which is dependent on when the bowhead whale quota is reached. Bearded seals are harvested more often than the smaller hair seals, because of their large body size and thick hides. They are hunted in both the Chukchi and Beaufort seas during the summer months and from open water while hunters are pursuing other marine mammals (North Slope Borough 1998).

Table 3-27. Annual cycle of subsistence activities, Barrow

Species	Winter					Spring		Summer			Fall	
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Fish	▨							▨	■	■	■	■
Birds							▨	■	■	■	▨	▨
Berries										■	■	
Furbearers	▨	▨	▨	■	■							
Caribou	▨	▨	▨	▨	▨	▨		▨	■	■	■	■
Polar Bear			▨	▨	▨			▨				
Moose												
Seals	■	▨	■			▨	■	■	■			
Walrus								▨	■	▨		
Bowhead						■	■	▨		■	■	■

	No to very low levels of subsistence activity
▨	Low to medium levels of subsistence activity
■	High levels of subsistence activity

Sources: Steven R. Braund and Associates and Institute of Social and Economic Research (1993) and Steven R. Braund and Associates (2003a).

Once the spring whaling season is over, usually in late May or early June, subsistence activities diversify. Some hunters turn their attention to hunting seals, walrus, and polar bears, while others go inland to fish or hunt for waterfowl and caribou. The harvest of eiders and geese begins in early to mid-May, weather and ice conditions permitting. In June, Iñupiaq hunters hunt geese and opportunistically harvest caribou, ptarmigan, and eiders. Residents of Barrow harvest eiders during the "fall migration" in September at Piġniq or "Duck Camp," which is located north of town and is road-accessible.

Barrow hunters harvest caribou in April, but usually refrain from taking caribou during May because of calving and the spring thaw. Barrow residents harvest the largest number of caribou in July and August, when they are available to people hunting from boats. In addition, caribou are in peak condition in August, and Barrow hunters prefer to harvest them at that time (Fuller and George 1997). Barrow hunters also harvest marine mammals, eiders, and fish in August, depending on the weather and ice conditions. Bearded seals are harvested principally for their blubber, which is rendered into oil, and their skins, which are used for boat coverings. Barrow hunters harvest ringed seals primarily for their meat. Walrus are harvested in July and August when they drift north with the floe ice, provided the pack ice moves close enough to Barrow.

Freshwater fishing occurs from breakup (June) through November. Residents fish for arctic cod year-round, but broad whitefish, the most heavily harvested species, are harvested from June to October. Fish harvested in August include whitefish, grayling, salmon, and capelin. Inland fishing intensifies when whitefish and grayling begin to migrate out of the lakes into the major rivers in August. This is also the peak harvest period for berries and greens (Schneider et al. 1980, Alaska Consultants, Inc. et al. 1984). Families may go up the Colville River to harvest moose and berries during moose hunting season in August and early September.

If ice conditions are favorable, fall bowhead whaling may occur as early as mid-August and continue into October. Residents of Barrow who remain inland hunt caribou if the animals are accessible; otherwise, they concentrate on fishing for grayling and burbot. The subsistence fish harvest generally peaks in October (under-ice fishery) when whitefish and grayling are concentrated in overwintering areas (Fuller and George 1999). Barrow residents also harvest ground (or parka) squirrels and ptarmigan, and, if weather and ice conditions permit and the animals appear close to town, seal and caribou are harvested during November and December (Steven R. Braund and Associates and Institute of Social and Economic Research 1993). During the winter months, residents of Barrow harvest furbearers, and hunt a small number of polar bears in the winter and spring.

Subsistence Harvests

Barrow's total annual subsistence harvests ranged from 621,067 pounds in 1987 to 1,363,736 pounds in 1992 (Steven R. Braund and Associates and Institute of Social and Economic Research 1993). The 1992 harvest of 349 pounds per capita of wild resources represents nearly 1 pound per day per person in the community. Barrow residents rely heavily on large land and marine mammals and fish. During a 3-year study by Steven R. Braund and Associates and Institute of Social and Economic Research (1993), marine mammals comprised approximately 55 percent of the total harvest, and land mammals contributed 30 percent of the total. Fish constituted approximately 7 percent of the total harvest in Barrow, with broad whitefish being the most important fish resource (4 percent of the total harvest). Birds (eiders and geese) contributed less than 2 percent of the total harvest by weight; however, participation in bird hunting was high (Fuller and George 1999).

The harvest of bowhead whales involves a far more concentrated and intense effort than the harvest of other animals. Bowhead whales are very important in the subsistence economy, and accounted for over 21 percent (an average of 10 whales per year) of the annual Barrow subsistence harvest from 1962 to 1982 (Stoker 1983). During the final year of a study in 1989, data indicated that approximately 58 percent of the total harvest was marine mammals and close to 43 percent of the total harvest were bowhead whales (Steven R. Braund and Associates and Institute of Social and Economic Research 1993, Alaska Department of Fish and Game 2001). Barrow's harvest of bowhead whales has increased since that time: from 1990 to 2005, the average was 21 whales per year (USDOI MMS 2008).

Barrow whalers hunt bowhead whales from camps located along the coast from Point Barrow to the Skull Cliff area. There are approximately 30 spring whaling camps along the edge of the landfast ice. While the locations of these camps depend on ice conditions and currents, most whaling camps are located southeast of Point Barrow. The distance of the leads (section of open water) from shore varies from year to year. The leads are generally parallel to and quite close to shore. Occasionally Barrow whalers must travel over the ice as far as 10 miles offshore to reach the lead, but the lead is typically open from Point Barrow, and hunters hunt whale only 1 to 3 miles from shore. A stricken whale can be chased in either direction in the lead, weather permitting. Spring whaling in Barrow is conducted almost entirely with skin boats, which are easier to maneuver than aluminum skiffs, and do not transmit sounds that could alert nearby whales (Alaska Consultants, Inc. et al. 1984, Steven R. Braund and Associates and Institute of

Social and Economic Research 1993). In the fall, whaling occurs east of Point Barrow, from the Barrow vicinity to Cape Simpson. During the fall migration, Iñupiaq whalers use aluminum skiffs with outboard motors to pursue the whales in open water, up to 30 miles offshore.

The annual average number of beluga whales harvested in Barrow, between 1962 and 1982, was estimated to be five whales, or less than 1 percent of the total annual subsistence harvest (Stoker 1983). In Steven R. Braund and Associates and the Institute of Social and Economic Research's study, there were no harvests of beluga whales in the 3-year period of data collection; however, non-sampled households might have harvested some beluga whales (Steven R. Braund and Associates and Institute of Social and Economic Research 1993, Alaska Department of Fish and Game 2001). The annual subsistence harvest for the eastern Chukchi Sea was reported to be approximately 60 beluga whales per year by the NOAA Fisheries Service (Angliss and Lodge 2002). Since 1987, the Alaska Beluga Whale Committee recorded 23 beluga whales taken by Barrow hunters, ranging from 0 in 1987, 1988, 1990, and 1995 to 2 in 1992, to a high of 8 in 1997 (Fuller and George 1999). USDOI Minerals Management Service has compiled data on beluga harvests from 1980 to 2006 and reported that Barrow took one beluga each year from 1998 to 2002, two belugas in 2003, one in 2004, and seven in 2006 (USDOI MMS 2008).

Ringed seals are the most common hair seal species harvested by Barrow residents. From 1962 to 1982, hair seal harvests were estimated at between 31 and 2,100 seals a year. The average annual harvest from 1962 to 1982 was estimated at 955 seals, or 4 percent of the total annual subsistence harvest (Stoker 1983). During 1987 through 1989, ringed seals provided approximately 2 percent of the total edible pounds harvested (Steven R. Braund and Associates and Institute of Social and Economic Research 1993, Alaska Department of Fish and Game 2001). The hunting of bearded seals is an important subsistence activity in Barrow. Bearded seal meat is a preferred food, and the skins are used to cover skin boats for whaling. Six to nine bearded seals' skins are needed to cover a boat. Bearded seals are harvested more often than the smaller hair seals because of their large body size and thick hides. The average annual subsistence harvest of bearded seals from 1962 to 1982 was 150 seals, or approximately 3 percent of the total annual subsistence harvest (Stoker 1983). The reported average annual harvest of 174 bearded seals during the 1987 to 1989 period provided slightly more than 4 percent of the total edible pounds harvested for those study years (Steven R. Braund and Associates and Institute of Social and Economic Research 1993).

The annual average harvest of walrus from 1962 to 1982 was estimated at 55 individuals, or approximately 5 percent of the total annual subsistence harvest (Stoker 1983). The 1987 to 1989 study indicated a greater walrus harvest than reported earlier; an annual harvest of 81 walrus provided 9 percent of the total edible pounds of meat harvested, ranging from a low of 1 walrus harvested in 1989 to a high of 30 in 1993 (Stephensen et al. 1994). Between 1990 and 2005, the harvest ranged from 5 to 52 animals with an average harvest of 26 animals (USDOI MMS 2008).

Caribou, the primary terrestrial source of meat for Barrow residents, are available throughout the year, with peak harvest periods from February through early April and from late June through late October. Over the 20-year period from 1962 to 1982, residents harvested an annual average of 3,500 caribou, which accounted for 58 percent by weight of the total annual subsistence harvest (Stoker 1983). From 1987 through 1989, caribou provided 22 to 30 percent of the total edible pounds harvested by Barrow residents (Steven R. Braund and Associates and Institute of Social and Economic Research 1993, Alaska Department of Fish and Game 2001). Caribou harvest surveys of Barrow residents conducted by the Alaska Department of Fish and Game Subsistence Division, the Iñupiat Community of the Arctic Slope, and the BLM provide the following community total estimates for three consecutive reporting years; 5,641during the 2002–2003 reporting year; 3,548 in 2003–2004; 4,338 in 2004–2005; and 4,535 in 2005-2006 (Braem et al. 2010).

Barrow residents harvest marine and riverine fish, such as capelin, char, cod, grayling, salmon, sculpin, trout, and whitefish (Alaska Consultants, Inc. et al. 1984); however, their dependency on fish varies with the availability of other resources. From 1969 to 1973, the average annual harvest of fish was about 80,000 pounds (Craig 1987); from 1962 to 1982, the estimated annual average was 60,000 pounds (Stoker 1983). In a 1986 partial estimate of fish harvests for the Barrow fall fishery in the Inaru River, the catch included least cisco (45 percent), broad whitefish (36 percent), humpback whitefish (16 percent), arctic cisco (1 percent), fourhorn sculpin (1 percent), and burbot (less than 1 percent, Craig 1987). Fish harvests from 1987 to 1989 were approximately 80,000 pounds annually and provided approximately 11 percent of the total annual edible subsistence harvest (Steven R. Braund and Associates and Institute of Social and Economic Research 1993).

Migratory birds, particularly eider ducks and geese, provide an important food source for Barrow residents because of their dietary importance during spring and summer. In May, hunters travel great distances, along major inland rivers and lakes, to harvest geese, while most eider and other ducks are harvested along the coast (Schneider et al. 1980). Snowy owls have been documented as an occasional food resource harvested by the residents of Barrow (Spencer 1959, Pedersen 1979). However, recent harvest documentation shows little use of snowy owls as a subsistence resource (Fuller and George 1997, Alaska Department of Fish and Game 2001). Bird eggs are still gathered occasionally, especially on the offshore islands where foxes and other predators are less common. Barrow residents harvested an estimated annual average of 8,000 pounds of birds from 1962 to 1982, which accounted from approximately 1 percent of the total annual subsistence harvest (Stoker 1983). From 1987 to 1989, 74,145 pounds of birds were harvested, accounting for approximately 4 percent of the total edible pounds harvested (Steven R. Braund and Associates and Institute of Social and Economic Research 1993, Alaska Department of Fish and Game 2001).

Subsistence Use Areas

The community of Barrow incorporates residents from throughout the North Slope Borough. Many residents may hunt in the areas where they were raised, which may include the subsistence harvest areas of other communities. Pedersen (1979) documented Barrow lifetime subsistence use areas in the 1970s, and Steven R. Braund and Associates and Institute of Social and Economic Research (1993) conducted a 3-year subsistence harvest study in Barrow for the 1987 to 1989 harvest years. With few exceptions, generally associated with offshore and furbearer use, the harvest locations for the 1987 to 1989 study period are located within Pedersen's (1979) Barrow lifetime community land use area as depicted in Maps 3.4.3-4 and 3.4.3-5. The documented Barrow subsistence use area represents a large geographic area, extending from beyond Wainwright in the west to the Kuparuk River in the east and south to the Avuna River. Inland use areas go beyond the Colville River to the foothills of the Brooks Range. The Barrow subsistence harvest data from both the 1970s and the 1980s and through the 1990s to 2003 (Stephen R. Braund and Associates 2003b, 2003a), show Barrow residents using the Colville River Delta area for subsistence activities.

Hunters interviewed by Stephen R. Braund and Associates (2003b) used the area east of Cape Halkett to pursue wolf, wolverine, and caribou. The winter wolf, wolverine, and caribou hunting areas overlapped, as hunters looking for wolf and wolverine tended to travel over great distances and they also harvested caribou on their travels. In summer, the caribou use area extended down the coast from Smith Bay to Cape Halkett, across the coastal areas of Harrison Bay, to the Colville River Delta and up the Colville River as far as Ocean Point. Several Barrow families have relatives living in Nuiqsut, and people commonly move back and forth between the two communities. Many Barrow residents have ancestral ties to areas between Barrow and Nuiqsut, and people continue to return to those areas for subsistence activities at traditionally used places. Barrow hunters use the planning area primarily for caribou, moose, and furbearers (wolf and wolverine). One Barrow interviewee indicated he had hunted moose in the Colville River from south of Umiat to approximately Ocean Point. The hunters indicated that they fished as far east as the lakes in the vicinity of Cape Halkett.

Several families now living in Barrow have elders who were born and raised along the coast between Smith Bay and the Colville River Delta. These families had moved to Barrow primarily because of the requirement that children attend school, with some moving to take jobs or access medical care. Most moved to Barrow in the late 1940s. Once they resided in Barrow, each family made special efforts to return to the coast from Smith Bay to the Cape Halkett area to continue traditional subsistence activities at traditional family harvest areas. Currently, the third generation of these families continues to use the area, often harvesting resources that are less available in the Barrow area, such as furbearers (wolf, wolverine, fox, and Arctic ground squirrels), caribou, and moose. Seal and fish are harvested closer to Barrow.

The approximate boundary for Barrow's primary subsistence harvest area for caribou, as reflected in research conducted in the late 1980s and early 1990s, extends southwest from Barrow along the Chukchi coast for roughly 35 miles, then runs south and eastward toward the drainage of the upper Meade River. It heads easterly, crossing the Usuktuk River, and then trends north and east, crossing the Topaguruk and Oumalik rivers, until it reaches Teshekpuk Lake; from here the boundary generally follows the coastline back to Barrow (Steven R. Braund and Associates and Institute of Social and Economic Research 1993). A Barrow hunter described a recent summer caribou hunt as follows:

> When the Western Arctic Herd are further west from Barrow in Point Lay or Point Hope, that's too far to travel. We had to go east through the ocean to the Cape Halkett area and go into creeks looking for caribou. On nice warm days, you find caribou on the coast and in the water, in the end of July or the first part of August. We go for one week. My uncle has a cabin near Cape Halkett (Stephen R. Braund and Associates 2003b).

Furbearer hunts are unlike subsistence food resource hunts in that they involve friendly competition. Furs are not shared in the same way as food resources, and the hunts are conducted over much larger areas. One hunter stated in good humor, "We fish closest to our own territories, we do not try to step on each other's toes with fish, but we have no respect (for territory) when it comes to wolf and wolverines" (Stephen R. Braund and Associates 2003b). Barrow residents from the same families, noted for their connections with the Cape Halkett area, use a vast area to the south and east of Teshekpuk Lake for furbearer hunting, and go into the Fish and Judy creeks, Tingmiaqsiġvik River, Itkillik River, and Umiat areas while looking for wolves and wolverines. One hunter interviewed said, "I like to go to the south side of Teshekpuk Lake, Inigok, and Umiat before the snow is too soft to get wolves and wolverine for clothing" (Steven R. Braund and Associates 2003b). Another hunter, explaining his winter hunting by snowmachine, said:

> From February through March, I travel to the east for furbearers. I go down to Price River, then to Fish and Judy creeks, then through Inigok to the Ikpikpuk, back over to the Colville to Umiat, down through the Itkillik, back and forth in a circle, then up to Teshekpuk lake. I go on both sides of the river. By April the fur isn't so great, so I go home (Stephen R. Braund and Associates 2003b).

Hunters occasionally use the Kalikpik-Kogru rivers area for caribou during the summer, especially if caribou are not available closer to Barrow (Stephen R. Braund and Associates 2003b). The hunters travel by boat as far as Kogru River. It is likely that other Barrow hunters travel further east. This area is both an historic and current use area for several Barrow families. The Colville River Delta is on the eastern edge of Barrow's use area. Barrow residents use snowmachines to hunt for caribou, wolf, wolverine, and fox in winter near Fish and Judy creeks. Hunters also use cabins and camps near Teshekpuk Lake (e.g., Puviak and Inigok) and along the Ikpikpuk and Chipp rivers as bases for snowmachine travel.

In addition to the harvest of resources, use of these areas is important to Barrow residents for maintaining connection to family history, graves, structures, caches, ice cellars, campsites, and traditional harvest areas. Although there are high costs in fuel, time, equipment, and effort for these trips, the cultural connection to these traditional areas is strong.

Nuiqsut

The community of Nuiqsut (population 417 in 2006) is located about 35 miles south of the Beaufort Sea coast on the Niġlik channel of the Colville River in the Colville River Delta (USDOI MMS 2008). A diverse seasonal abundance of terrestrial mammals, fish, birds, and other resources is available in the area immediately surrounding Nuiqsut. Traditional subsistence activities in the Nuiqsut area revolve around the bowhead whale, caribou, fish, waterfowl, and ptarmigan. Moose and furbearers are important supplementary resources and, to a lesser extent, seals, muskoxen, and Dall sheep. Polar bears, beluga whales, and walruses may be taken opportunistically while in pursuit of other subsistence species (Alaska Biological Research 2007, Bacon et al. 2009, Galganaitis 2009, North Slope Borough 2007).

Nuiqsut's location on the Colville River is a prime area for fish and caribou harvests, but is less advantageous for marine mammal harvests (Alaska Department of Community and Economic Development 2003). The Colville River is the largest river system on the North Slope and supports the largest overwintering areas for whitefish (Craig 1989a).

In 1973, 27 Barrow families moved to the area and permanently resettled Nuiqsut, and the Arctic Slope Regional Corporation funded construction of the modern village in 1974. The Nuiqsut area was formerly a gathering and trading place for the Iñupiat and Athabascans. Such gatherings maintained connections between the inland Nunamiut and the Taremiut of the coast (Brown 1979). The Alaska Native Claims Settlement Act allowed Iñupiat from Barrow who wished to live in a more traditional manner to select the site for resettlement, and many of those who moved there had some family connection to the area (Impact Assessment, Inc. 1990a, 1990b). Easy access to the main channel of the Colville River for fishing, hunting, and ease of movement between upriver hunting sites and downriver whaling and sealing sites was the primary reason for selection of the site (Brown 1979).

Seasonal Round

The seasonal availability of many important subsistence resources directs the timing of subsistence harvest activities (Table 3-28). Beginning in March, Nuiqsut residents hunt ptarmigan. Waterfowl hunting begins in the spring, and hunters typically harvest ducks and geese while participating on other subsistence activities such as fishing for burbot or lingcod (Impact Assessment, Inc. 1990a, 1990b). Fishing may occur year-round, but it is most common from breakup (late June) through November (Fuller and George 1999).

Table 3-28. Annual cycle of subsistence activities, Nuiqsut

Species	Winter					Spring		Summer			Fall	
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Fish	■	□	▒	▒	▒	▒	▒	■	■	■	▒	■
Birds/Eggs	▒	▒	▒	▒	▒	■	■	■	■	▒	▒	■
Berries	□	□	□	□	□	□	□	▒	▒	■	□	□
Moose	□	□	□	□	□	□	□	□	▒	■	▒	□
Caribou	▒	■	▒	▒	■	■	■	▒	■	■	▒	■
Furbearers	▒	▒	▒	▒	▒	■	▒	□	□	□	□	▒
Polar Bear	■	▒	▒	▒	▒	▒	▒	□	□	□	▒	▒
Seals	▒	▒	□	□	▒	■	▒	■	■	■	■	▒
Bowhead	□	□	□	□	□	□	□	□	□	▒	■	□

□	No to very low levels of subsistence activity
▒	Low to medium levels of subsistence activity
■	High levels of subsistence activity

Sources: Research Foundation of the State University of New York (1984), Impact Assessment, Inc. (1990), and Steven R. Braund and Associates (2003a).

Caribou are harvested primarily during the late summer and fall months, but are hunted year-round. Moose hunting takes place in August and September in boat-accessible hunting areas south of Nuiqsut (Fuller and George 1999). August is the primary harvest month for caribou and moose because water levels are right for traveling upriver or on the coast by boat, the animals are usually in their best condition and moose are legal to hunt in Game Management Unit 26 for subsistence harvesters. Berries are seasonally important.

Many Nuiqsut residents participate in subsistence fishing. If weather and ice conditions permit, summer net fishing at fish camps or near the community begins in June or July. Gill netting at campsites is most productive between October and mid-November. Fishing for grayling also occurs in the fall. Furbearer hunters pursue wolves and wolverines thorough the winter months, primarily in mid-March and April. Furbearer hunting can be undertaken anytime during the winter; however, most hunters avoid going out in the middle of winter because of poor weather conditions and lack of daylight (Impact Assessment, Inc. 1990a, 1990b).

Nuiqsut's location on the Niġliq Channel of the Colville River, with large resident fish populations, reflects the importance of fish to subsistence users. The river supports 20 species of fish, approximately half of which are taken by Nuiqsut residents (George and Nageak 1986). Local residents generally harvest fish during the summer and fall. The summer, open-water harvest lasts from breakup to freeze-up (early June to mid-September). The summer harvest covers a wide area, is longer than the fall/winter harvest in duration, and a greater number of species are caught. Broad whitefish, the primary species harvested during the summer, is the only anadromous species harvested in July. Thomas Napageak related that "in the summer when it is time to fish for large, round-nosed whitefish, the place called Tirragruag gets filled with them, as well as the entrance to Itkillik. Niġliq River gets filled with nets all the way to the point where it begins. We do not go to Kuukpiluk in the summer months. Then we enter Fish Creek...another place where they fish for whitefish is Nuiqsagruaq" (USDOI BLM and MMS 1998).

In July, lake trout, northern pike, broad whitefish, and humpback whitefish are harvested by residents of Nuiqsut. Traditionally, coastal areas were fished in June and July when rotting ice created enough open water for seining. Nuiqsut elder Sarah Kunaknana, interviewed in 1979, said: "...in the little bays along the coast we start seining for fish (iqalukpik). After just seining one or two times, there would be so many fish we would have a hard time putting them all away" (Shapiro et al. 1979). Salmon species reportedly have been caught in August, but not in large numbers. Pink and chum salmon are the species most commonly caught (George and Nageak 1986). Arctic char is found in the main channel of the Colville River, but is not abundantly caught (George and Kovalsky 1986, George and Nageak 1986, Alaska Department of Fish and Game 2001).

The fall/winter under-ice fish harvest begins after freeze-up, when the ice is safe for snowmachine travel. Local families fish for approximately 1 month after freeze-up, until the river ice is too thick to allow the setting of nets through holes in the ice. The Kuukpigruaq Channel is the most important fall fishing area in the Colville River region, and the primary species harvested are arctic and least cisco.

Even though Nuiqsut is not located on the coast (it is approximately 35 miles inland with river access to the Beaufort Sea), bowhead whales are a major subsistence resource. Bowhead whaling is usually undertaken between late August and early

October from Cross Island, with the exact timing depending on ice and weather conditions. Ice conditions can dramatically extend the season up to 2 months or contract it to less than 2 weeks. Unlike Barrow spring whaling, where the hunt is staged from the edge of ice leads using skin boats, Nuiqsut whalers use aluminum skiffs with outboard motors to hunt bowhead whales in open water in the fall. Generally, bowhead whales are harvested by Nuiqsut residents within 10 miles of Cross Island, but hunters may travel much further from the island (Galganaitis 2009). Nuiqsut hunters harvest few polar bears, but when they are harvested, it is often the fall whaling season.

Seals are hunted nearly year-round, but the bulk of the seal harvest occurs during the open-water season. In the spring, seals may be hunted once the landfast ice goes out. Present day sealing is most commonly done at the mouth of the Colville River when it begins flooding after breakup in June. According to Thomas Napageak:

> ...when the river floods, it starts flowing out into the ocean in front of our village affecting the seals that include the bearded seals in the spring month of June. ...When the river floods, near the mouth of Niġliq River it becomes filled with a hole or thin spot in [the] sea ice that has melted as the river breaks up. When it reaches the sea, that's the time that they begin to hunt for seals, through the thin spot in the sea ice that has melted. They hunt for bearded seals and other types of seals (USDOI BLM and Minerals Management Service 1998).

Nuiqsut hunters described three species of terrestrial furbearers as being especially important: wolf, wolverine, and fox (Steven R. Braund and Associates 2003b). Once there is adequate snow in the winter for snowmachine travel, usually by November, hunters seriously begin the pursuit of wolf and wolverine.

Subsistence Harvests

Subsistence activities are important components of the Nuiqsut economy and of local Iñupiaq culture and identity (Impact Assessment, Inc. 1990a, 1990b). A 1993 Alaska Department of Fish and Game subsistence study showed that nearly two-thirds of all Nuiqsut households received more than half of their meat, fish, and birds from local subsistence activity (Pedersen 1995). This activity is supported by the cash component of the mixed economy. Nuiqsut is situated closer to current and foreseeable areas of petroleum development that any other community on the North Slope. This development has deterred subsistence resource users from hunting, fishing, and gathering at their former harvest areas east of the Colville River and at coast areas such as Oliktok Point (Impact Assessment, Inc. 1990a and 1990b, Fuller and George 1999). As employment has increased in Nuiqsut, jobs are being filled by people who move into the community from elsewhere and who may not have the time, knowledge, or inclination to attempt to harvest subsistence foods in the Nuiqsut area. As long-term local residents continue to be underemployed, the value of subsistence foods continues as a lower cost alternative to imported foods (Circumpolar Research Associates 2002). However, a determinative link between household wage income and household subsistence productivity has not been demonstrated; the former is apparently dependent on education levels, and the latter on the number of capable producers in the household (Pedersen et al. 2000).

Nuiqsut's total annual subsistence harvests ranged from 160,035 pounds in 1985 to 267,818 pounds in 1993. The 1993 harvest of 742 pounds per capita of wild resources represents approximately 2 pounds per day per person in the community. In 1985, fish and land mammals accounted for 86 percent of Nuiqsut's total subsistence harvest, and marine mammals contributed 8 percent. In 1993, fish, land mammals, and marine mammals accounted for approximately one-third each. The importance of subsistence to Nuiqsut residents is further reflected in the high participation rates in 1993 in households that harvest (90 percent), try to harvest (94 percent), share (98 percent), and use (100 percent).

Nuiqsut whalers have not always harvested bowhead whales consistently in the past (20 whales from 1972–1995), but their success has improved in recent years. Unsuccessful harvests were common in the 1980s, with no whales taken in 1983–1985 or 1988; however, in the 1990s, the only unsuccessful years were 1990 and 1994 (USDOI MMS 1996a, U.S. Army Corps of Engineers 1998). From 1997 to 2010, three or four bowhead have been harvested every year except 2009 (two whales) and 2005 when, due to extreme ice conditions, only one bowhead was landed (USDOI MMS 2008, Nukapigak 2011).

Nuiqsut residents have indicated that beluga whales are not significant to the subsistence cycle of the community. In 1989, Thomas Napageak stated: "I don't recall a time when I went hunting for beluga whales. I've never seen a beluga whale here" (USDOI BLM 1998b). In 1990, a stray beluga whale that came up the Colville was taken by an elder hunter and it is remembered by Nuiqsut residents as the only beluga harvested in recent history (Nukapigak 2011).

Seals are a culturally important subsistence species for food, skins, and barter. In historic times, seal oil provided fuel for heat and light for Iñupiaq dwellings and a condiment for dried food. Seal meat and oil are still locally consumed and traded to Anaktuvuk Pass for dried caribou and other products. Seal skins are used for handicrafts and other articles, bartered, or sold (Steven R. Braund and Associates 2003b). A 1993 Alaska Department of Fish and Game subsistence survey in Nuiqsut indicated that 32 percent of the total subsistence harvest was marine mammals, and 3 percent of the total harvest was seals (Alaska Department of Fish and Game 2001). Fuller and George (1999) estimated that 24 ringed seals, 16 bearded seals, and 6 spotted seals were harvested in 1992, and that overall, marine mammals (including bowhead whales) contributed 35 percent to the total subsistence harvest. A subsistence harvest survey conducted by the North Slope Borough Department of Wildlife Management, covering July 1994 to June 1995, reported a harvest of 23 ringed seals and a 2 percent contribution of marine mammals to the total subsistence harvest because no bowhead whales were harvested that season (Brower and Opie 1997, Brower and Hepa 1998).

Alaska Department of Fish and Game subsistence survey data indicate that two walruses were harvested in the 1985–1986 harvest season. No new walrus data for the community have been gathered since 1986 (Alaska Department of Fish and Game 2001) but a Nuiqsut whaling captain and hunter recalls that those two were the only walrus harvested in recent history (Nukapigak 2011). Nuiqsut residents have also indicated that polar bears are not a significant subsistence resource for the community and, if taken, would be an incidental harvest taken during seal hunting (North Slope Borough 1998). One polar bear was reported harvested between 1962 and 1982, and 20 were harvested between 1983 and 1995 (Stoker 1983, Schleibe et al. 1995, Brower and Opie 1997, Brower and Hepa 1998, North Slope Borough 1998, Alaska Department of Fish and Game 2001). Whaling captain Nukapigak (2011) estimates that an average of one polar bear per year is harvested by Nuiqsut hunters.

Nuiqsut hunters harvest several large mammals, including caribou and moose. Caribou may be the most preferred mammal in Nuiqsut's diet, and during periods of high availability, it provides a source of fresh meat throughout the year. In 1985, Nuiqsut hunters harvested an estimated 513 caribou, providing 60,000 edible pounds of meat, or 38 percent of the total subsistence harvest (Alaska Department of Fish and Game 2001). Fuller and George (1999) estimated that 278 caribou were harvested in 1992. A 1993 Alaska Department of Fish and Game subsistence study estimated a harvest of 672 caribou, providing 82,000 edible pounds of meat, or 31 percent of the total subsistence harvest (Alaska Department of Fish and Game 2001). In 1993, 74 percent shared caribou with other households, and 79 percent received caribou shares (Alaska Department of Fish and Game 2001). A subsistence harvest survey, covering July 1994 to June 1995, reported that Nuiqsut hunters harvested 258 caribou, which made up 58 percent of the total subsistence harvest in edible pounds (Brower and Hepa 1998). Caribou harvest surveys of Nuiqsut residents conducted by Iñupiat Community of the Arctic Slope and the Alaska Department of Fish and Game provide the following community estimates for four consecutive reporting years: 397 during the 2002–2003 reporting year; 564 in 2003–2004; 546 in 2004–2005; and 363 in 2005–2006 (Braem et al. 2010).

Although small numbers of moose are harvested, they are a valued component of the subsistence harvest in Nuiqsut, and hunters spend considerable effort in their pursuit. Moose offer a significant amount of meat per animal harvested because of their relatively large size compared to other terrestrial mammal subsistence resources (Steven R. Braund and Associates 2003b).

Fish provide the most edible pounds, per capita, of any subsistence resources harvested by Nuiqsut. While variable by season and from year to year, fish provide a relatively stable, predictable, and substantive contribution to subsistence resource harvest. The subsistence harvesting of fish is not subject to seasonal limitations under federal fisheries management, and no permit is required for rural residents, a situation that adds to their importance in the community's subsistence round. Nuiqsut has the largest documented subsistence fish harvest on the Beaufort Sea Coast (Moulton et al. 1986, Moulton 1997). On occasion, fish may provide the only source of fresh, easily accessed subsistence food.

The summer fish catch in 1985 totaled about 19,000 pounds, mostly of broad whitefish. In the fall, approximately 50,000 pounds of fish were caught for an annual per capita catch of 244 pounds, and some of this catch was shipped to Barrow (Craig 1987). A 1985 Alaska Department of Fish and Game subsistence survey estimated the edible pounds of all fish harvested at 176 pounds per capita, or approximately 44 percent of the total subsistence harvest. In 1992, 35 percent of the edible pounds of Nuiqsut's total subsistence harvest was fish, and by 1993, the estimate of edible pounds of all fish harvested had risen to approximately 251 pounds per capita, or approximately 34 percent of the total subsistence harvest. A subsistence harvest survey conducted by the

North Slope Borough Department of Wildlife Management, covering July 1994 to June 1995, reported that the subsistence fish harvested provided 30 percent of the total subsistence harvest (Brower and Opie 1997, Brower and Hepa 1998).

The most important species of waterfowl for Nuiqsut hunters are Canada and white-fronted geese and brant; eiders are also harvested. Ruth Nukapigak relates that "...when the white-fronted goose come, they do hunt them. When the thin ice near the mouth of the river breaks up, that is when they start duck hunting. We, the residents of Nuiqsut, go there to hunt for ducks when they arrive," (USDOI BLM and MMS 1998). The only upland bird hunted extensively is the ptarmigan (Brower and Hepa 1998, Alaska Department of Fish and Game 2001). Recent data indicated that the bird harvest provides 5 percent of the total subsistence harvest (Brower and Hepa 1998).

Subsistence Use Areas

The Iñupiaq community of Nuiqsut has subsistence harvest areas in and adjacent to the planning area. Nuiqsut's marine subsistence harvest area is in the Beaufort Sea from Cape Halkett in the west to Flaxman Island in the east, and up to 30 miles offshore. Before oil development at Prudhoe Bay, the onshore area from the Colville River Delta in the west to Flaxman Island in the east, inland to the foothills of the Brooks Range, and especially up the drainages of the Sagavanirktok, Colville, Itkillik and Kuparuk rivers, were historically important to the Iñupiat for subsistence harvests of caribou, waterfowl, furbearers, fish, and polar bears.

Pedersen (1979) documented Nuiqsut "lifetime" and 1973 to 1986 land use areas. Brown (1979) and Hoffman et al. (1988) also documented Nuiqsut subsistence use areas in the 1970s, which are incorporated within the lifetime use areas depicted in Pedersen (1979) (Map 3.4.3-6). Stephen Braund and Associates (Braund and Associates 2010) has published information on contemporary Nuiqsut subsistence use areas.

Many of those who resettled Nuiqsut were experienced whalers and crew who remembered past whale harvests before the temporary abandonment of the settlement (Impact Assessment, Inc. 1990a, 1990b), and Nuiqsut has been a bowhead whaling community since its reestablishment in 1973. Nuiqsut whaling occurs in the fall when the whales migrate closer to shore because the spring migration path is too distant from shore for effective hunting with small boats. In the past, Nuiqsut crews used Narwhal Island as a base and still have structures there. They now travel approximately 100 miles from Nuiqsut to the Cross Island whaling camp (approximately 15 miles from West Dock on the west side of Prudhoe Bay), where they have cabins and equipment for hauling up and butchering the whales. They typically travel out either the Niglik or the main Colville channel of the Colville River Delta, depending on water levels, and travel along the coast or just inside the barrier islands. The general Nuiqsut harvest area for bowhead whales is located off the coast between the Kuparuk and Canning rivers (Galganaitis 2009) but hunting activities over the last 10 years have occurred almost as far as Thetis Island to the west and Barter Island (Kaktovik) to the east and offshore up to approximately 50 miles (Braund and Associates 2010).

Ringed, spotted, and bearded seals are important subsistence resources for Nuiqsut hunters. Seals are harvested along the coast and offshore from Cape Halkett in the west and to Foggy Island Bay in the east. In the summer, Nuiqsut hunters harvest ringed and spotted seals in the Colville River as far south as Ocean Point. In the spring, hunters usually shoot seals in the water and on the ice edge (Steven R. Braund and Associates 2003b). In April and May, hunters ride out to Harrison Bay on snowmobiles and look for breathing holes—cracks in the ice and open water where seals might surface to breath. By the second week in June, open waters on the Colville River and much of Harrison Bay allow hunters to take boats out on a route called "around the world." This route follows the Niglik Channel to Harrison Bay, west to Atigaru Point, along the ice edge out as far as 28 miles, then to Thetis Island (called Amauliqtuq), east to Oliktok Point, and back south through the main channel of the Colville River. Thetis Island is used as a shelter when the weather turns bad. This route is also used to harvest eiders, and occasionally walruses (Steven R. Braund and Associates 2003b).

Harvest location data for caribou collected by the North Slope Borough (Brower and Hepa 1998, North Slope Borough 2003, Alaska Department of Fish and Game 2001, 2003), hunting area interviews (Steven R. Braund and Associates 2003b) conducted in Nuiqsut for the Alpine Satellite Development Project EIS, and contemporary use area information collected by Braund and Associates in recent years (Braund and Associates 2010) indicated that there are several primary harvest areas for caribou. North of Nuiqsut, these harvest locations include the Nuiqsut area, the Colville River Delta, the Nigliq Channel, and the Fish and Judy creeks area. To the south of Nuiqsut, the Colville River provides access to areas and sites such as Itkillilpaat, Ocean Point, the Itkillik River, Umiat, and the confluences of the Anaktuvuk and Chandler rivers. West of Nuiqsut are some of the most important remaining subsistence use areas for terrestrial mammals, including caribou, wolf, and wolverine. Nuiqsut hunters travel as far west as Barrow, and some reported traveling to within sight of Atqasuk, in pursuit of subsistence resources, particularly when they are less abundant near Nuiqsut. Travel to the east is undertaken by heading south of the Kuparuk and Meltwater projects by snowmachine, then looping back north to the vicinity of Franklin Bluffs and sometimes beyond. Braund (2010) reported that several Nuiqsut residents commented that hunting has declined east of the community due to oil and gas development, and residents generally did not travel past the Sagavanirktok River to the east in search of caribou. In open water months, travel east is by boat along the coast to hunt caribou, seal, eider and sea ducks, and in fall to Cross Island for whaling. These areas are usually associated with Traditional Land Use Inventory sites, cabins, camps, and Native allotments with harvest locations for other species nearby. These harvest locations may be used in winter (October through May), summer (defined as the open water period, including June through September), or both, and they may be accessed by foot, boat, all-terrain vehicle, and snowmachine. Nuiqsut hunts use the general vicinity of Teshekpuk Lake to harvest caribou, wolves, and wolverines, and several Nuiqsut families, along with relatives in Barrow and Atqasuk, share use rights to cabins, camps, and allotments in the area and consider it their homeland.

Nuiqsut resource users have a long history of subsistence fishing in the Colville River and its tributaries from the Colville River Delta to the confluence with the Ninuluk Creek, in the Nigliq Channel and nearby Fish and Judy creeks, and in the innumerable lakes in the region. Nuiqsut fishermen also use coastal areas east to the Kuparuk River and fish around several barrier islands, including Thetis and Cross islands. Many families set nets near Nuiqsut in the Nigliq Channel when time, transportation needs, or funds do not permit longer trips from town, particularly during the school and work year. Cooperative arrangements are made between resource users wherein resources (such as time, equipment, gas, and labor) are pooled in exchanged for shares of the harvest. Resource users often fish in conjunction with other subsistence activities, such as caribou and moose hunting and berry picking, especially in harvest areas with camps and cabins. Certain species of fish are only seasonally available and must be harvested when present in the area. Nuiqsut fishers freeze or dry these fish for later use and barter. Other fish species are available year-round and provide fresh food as well as a welcome change in the diet during winter and spring (Steven R. Braund and Associates 2003b). A study of fishery monitoring from the 20-year period 1985–2004 showed a trend of increasing effort from the village of Nuiqsut due to greater familiarity with the distribution of arctic cisco in the region and an increasing user population (Moulton et al. 2009). Nuiqsut is uniquely positioned to harvest arctic cisco (*qaaktaq*) because a percentage of the fish's population, which originates in the MacKenzie River, overwinters in the Colville and feeds in the Beaufort Sea for approximately seven years before returning to the MacKenzie (Braund and Associates 2010).

Waterfowl harvested by the Iñupiat of Nuiqsut occupy two habitats in the greater Nuiqsut area. Ducks, geese, and brant molt and nest in the wet tundra to the north of Nuiqsut. Eiders nest in the sandy areas of the Colville River Delta and the barrier islands, molting after their arrival. Both groups of waterfowl raise their young in the area until fall, when they migrate south. Nuiqsut hunters harvest waterfowl during the migration in May and June using snowmachines and boats. The hunters harvest the migrating birds from snow blinds built to the south, near Sentinel Hill and Ocean Point or at Fish Creek. Once the river breaks up, hunters look for birds by boat, and start to look for eiders in the Colville River Delta and in Harrison Bay at the ice edge as summer approaches. Hunters end the waterfowl harvest when the birds are on their nests (Steven R. Braund and Associates 2003b).

In earlier times, Iñupiaq resource users harvested flightless molting birds by cooperatively "herding" them into creeks, then dividing the harvest between the work group members. One resident remembered doing this as recently as the late 1940s at Oliktok Point. Nuiqsut people in the past gathered and stored eggs from waterfowl nests on the tundra. According to the Steven R. Braund and Associates 2003 interviews, eggs are no longer gathered, and certain species of waterfowl are not harvested for various reasons. Some residents indicated that they do not eat certain varieties of ducks (e.g., oldsquaws, northern pintails), while many chose to avoid harvesting black brant and spectacled eider because they are species of concern. Nearly all interviewed resource users harvest geese in May, and most harvest some eiders when breakup allows boat travel on the river and in Harrison Bay (Steven R. Braund and Associates 2003b).

The harvest area for furbearers extends from the eastern edge of the Colville River Delta along the coast, almost to Admiralty Bay, and then south along the Ikpikpuk River to the Colville River, eastward to the Toolik River, north and crossing the Dalton Highway to Franklin Bluffs, and west and north back to the Colville River Delta (Steven R. Braund and Associates 2003b).

Wainwright

Located approximately 70 miles southwest of Barrow on the Chukchi Sea coast, the community of Wainwright enjoys a diverse resource base that includes both terrestrial and marine resources. Marine subsistence activities focus on the coastal waters from Icy Cape in the south to Franklin Point and Peard Bay in the north. The Kuk River lagoon system—a major marine estuary—is an important marine and wildlife habitat used by local hunters (Bacon et al. 2009, Quakenbush and Huntington 2010, Steven R. Braund and Associates 2009).

Seasonal Round

Wainwright's seasonal subsistence round is depicted in Table 3-29. Bowhead whales are Wainwright's most important marine resource. Until the fall of 2010, bowheads were only available in the Wainwright area beginning in late April for spring whaling with skin boats from the edge of the shorefast ice. In October 2010, Wainwright crews using Lund boats successfully took a bowhead whale from an area approximately 27 miles from town (15 miles north and 19 miles out). Elders recall having heard stories about fall bowhead harvest in Wainwright last occurring during the 1880s, during the era of commercial whaling. Nonetheless, Wainwright is not as ideally situated for bowhead whaling as Barrow or Point Hope. Beluga whales are available to Wainwright hunters during the spring bowhead whaling season (late April to early June); however, pursuing belugas during this time jeopardizes the bowhead whale hunt, so the beluga hunt occurs only if no bowheads are in the area. Belugas are also available later in the summer (July through late August) in the lagoon systems along the coast. The reluctance of Wainwright residents to harvest belugas during the bowhead-whaling season means the community must rely on an unpredictable summer harvest; consequently, the relative importance of the beluga whale varies from year to year (Nelson 1969, Alaska Consultants, Inc. et al. 1984).

Table 3-29. Annual cycle of subsistence activities, Wainwright

Species	Winter					Spring		Summer			Fall	
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Fish	▨	▨	▨	▨	▨				▨	■	■	▨
Birds/Eggs						■	■	■	▨	▨	▨	▨
Berries									▨	■	■	
Caribou	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	■	■
Furbearers	▨	▨	▨	▨	▨							
Seals		■	■			■	■	■	■	■	▨	▨
Walrus						▨	▨	▨	▨	▨	▨	
Whales							■	▨	▨	▨		

	No to very low levels of subsistence activity
▨	Low to medium levels of subsistence activity
■	High levels of subsistence activity

Source: Kassam 2001

Walruses are present seasonally in Wainwright, with the exception of a few that overwinter in the area. Until recently, the peak walrus hunting period occurs from July to August as the southern edge of the pack ice retreats. In late August and early September, Wainwright hunters occasionally harvest walrus that are hauled out on beaches. The focal area for hunting walruses is from Milliktaġvik north to Point Franklin. However, hunters prefer to harvest walruses south of their communities so northward-moving pack ice can carry the hunters toward home while they butcher their catch on the ice. This northward-moving current also helps the hunters return home in their heavily loaded boats (Nelson 1969).

Wainwright residents hunt four seal species: ringed, spotted, ribbon (all hair seals), and bearded seals. Ringed seals (the most common species) are generally available throughout the ice-locked months. Bearded seals are available during the same period, but they are not as plentiful. Although they are harvested less frequently, spotted seals are common in the coastal lagoons during the summer; most are taken in Kuk Lagoon. Ribbon seals occasionally are available during the spring and summer months. Ringed and bearded seals are harvested most intensely from May through July (Alaska Consultants, Inc. 1984). Most ringed seals are harvested along the coast from Milliktaġvik to Point Franklin, with concentration areas along the shore from Kuk Inlet southward to Milliktaġvik and from Nunagiaq to Point Franklin. Migrating seals are most concentrated at Qipuqlaich, just south of Kuk Inlet (Nelson 1969).

Wainwright residents harvest a variety of fish in most marine and freshwater habitats along the coast and in lagoons, estuaries, and rivers. The most important local fish harvest occurs from September through November in the freshwater areas of the Kuk, Kugrua, Utukok, and other river drainages (Craig 1987). Ice fishing for smelt and tomcod (saffroncod) occurs near the community, primarily during January, February, and March. In the summer months, Wainwright residents harvest Arctic char, chum, and pink salmon, Bering cisco and least cisco, grayling, lingcod, burbot, and rainbow smelt. Other species that are harvested less frequently along the coast, and in some cases in estuaries or freshwater, include rainbow smelt, flounder, cisco, saffron cod, arctic cod, trout, capelin, and grayling (Nelson 1969, Craig 1987). Marine fishing is conducted from Peard Bay to Icy Cape and in Kuk Lagoon.

Caribou is the primary source of meat for Wainwright residents. Before freeze-up, caribou hunting is conducted along the inland waterways, particularly along the Kuk River system. It is during this fall-time hunt that the majority of caribou are harvested by the community. Residents frequently harvest caribou opportunistically during the winter while out furbearer trapping and hunting.

The migration of ducks, swans, murres, geese, and cranes begins in May and continues through June. The waterfowl harvest is initiated in May at whaling camps and continues through June. Hunting decreases as the bird populations disperse to their summer ranges and nesting locations. During the fall migration south, the range is scattered over a wide area and, with the exception of Icy Cape, hunting success is limited (Alaska Consultants, Inc. 1984). Because the bowhead harvest and spring bird hunting periods overlap, hunters sometimes have to choose between the two activities. At whaling festivals following a successful bowhead harvest, geese are traditionally served as well. It is often the friends and relatives of a whaling captain who take care of providing geese for the feast. With brant, hunters prefer the taste of spring birds because they have not yet begun to eat vegetation from the inland freshwater habitat.

Brant that come through Wainwright in the spring are coming from saltwater lagoons near Cold Bay on the Alaska Peninsula. Many hunters do not like the new federal regulations requiring the use of steel shot, claiming that it does not bring down geese as well as lead shot (Kassam and Wainwright Traditional Council 2001).

Subsistence Harvests

From 1962 to 1982, the bowhead harvest accounted for 8.2 percent of the total annual subsistence harvest (an average of 1.5 whales taken each year) (Stoker 1983). The annual bowhead harvest has not varied as much as the harvest of other subsistence resources. However, since 1982, the number of whales taken has varied from 0 to 6, and the relative bowhead contribution to the total annual subsistence harvest has increased. In a subsistence study conducted in Wainwright from 1988 to 1989 (Steven R. Braund and Associates 1989), bowhead whale accounted for 42.3 percent of total edible pounds harvested while marine mammals made up 70 percent of the total edible pounds harvested. Two whales were harvested during the 1989 to 1990 season, and composed 29 percent of the total edible pounds harvested (Alaska Department of Fish and Game 2001). No bowheads were taken in 1992 and the marine mammal harvest was made up primarily of walrus, beluga whale, and bearded seal (Fuller and George 1997). From 1993 to 2005, Wainwright harvested an average of four bowhead whales per season.

Between 1962 and 1982, the annual average harvest of belugas is estimated at 11, or 2.7 percent of the total annual subsistence harvest (Stoker 1983). In Braund's studies (Steven R. Braund and Associates and Institute of Social and Economic Research 1989, 1993), two beluga whales were harvested, making up 1.1 percent of Wainwright's harvest in 1989. In 1990, no whales were harvested. During the 8-year period (1990–1998) the beluga harvest ranged between 0 and 38 animals. In 2001, 23 whales were taken (Fuller and George 1997). Thirty-seven and 38 whales were taken in 2002 and 2003, respectively, while 0 were harvested in 2004 and 1 in 2006 (USDOI MMS 2008).

From 1962–1982, the annual average harvest of walrus is estimated at 86, or 18.5 percent of the total annual subsistence harvest (Stoker 1983). In Braund's 1989 study, walrus composed 17.6 percent of the total harvest and in 1989 they accounted for 33.7 percent of the total harvest (Steven R. Braund and Associates 1989). Since 1989, the annual walrus harvest has ranged from 0 to 153 animals. In 1992, 82 walrus were harvested, composing 25 percent of the total subsistence harvest (Fuller and George 1997). From 1993 through 2005, an average of 56 walrus was harvested per year (USDOI MMS 2008).

The bearded seal harvest is an important subsistence activity in Wainwright, because it is a preferred food and the skins are used as covers for the whaling boats (Alaska Consultants, Inc. 1984). The best harvest areas for bearded seals are on the flat ice south of Wainwright, off Qilamittaġvik and Milliktaġvik and beyond, towards Icy Cape (Nelson 1969). Although no annual harvest data was available for bearded seals in the 1962–1982 22-year average computation, the annual average subsistence harvest (between 1962 and 1982) was estimated at 250 seals, or about 12.3 percent of the total annual subsistence harvest (Stoker 1983). In 1988, Braund (Steven R. Braund and Associates and Institute of Social and Economic Research 1989) documented that 97 bearded seals were harvested, accounting for 6.6 percent of the marine mammal harvest that year. One hair seal harvest during the past 20 years is estimated at between 250 and 1,600 seals. In recent years, approximately 250 hair seals have been harvested each year. In 1989, Braund recorded 98 hair seals (ringed and spotted), composing 1.1 percent of the total marine mammal harvest (Steven R. Braund and Associates 1991).

Traditionally, ringed and bearded seals were widely harvested. Today, bearded seal is the most sought after species and ringed seal is not considered as important (Kassam and Wainwright Traditional Council 2001). The bearded seal is considered a mainstay subsistence resource and is prized for its fat and meat. It is harvested from spring through fall. Smaller bearded seal are preferred for their meat and the larger ones are considered best for rendering oil. Some elders have commented that there is a change in the taste and texture of bearded seal meat and oil. The meat has a stronger taste when boiled and the oil rendered from the blubber is not white (Kassam and Wainwright Traditional Council 2001).

Between 1969 and 1973, the annual fish harvest was about 3,800 pounds. The annual per capita fish catch was 9 pounds (Craig 1987). Stoker (1983, as cited by Alaska Consultants, Inc. 1984) uses this data and lists fish as a minor resource in the total harvest of Wainwright subsistence resources (approximately 0.8 percent of the annual harvest averaged over 20 years). Nevertheless, fish were the third largest source of subsistence foods and the third most important species harvested in Wainwright in 1981. In Braund's study, fish made up 3.9 percent of the total harvest in 1989, with whitefish and least cisco the most important. In 1990, fish accounted for 4.9 percent of the total harvest, with least cisco and rainbow smelt again the most important species (Steven R. Braund and Associates and Institute of Social and Economic Research 1993). This increase in the importance of fish resources can be attributed to: (1) snow machines and motorized skiffs having made distant fish camps more accessible, and (2) a value change that has stimulated the residents' interest in fishing and camping away from the community (Nelson 1969).

The fish harvest plays an important role in strengthening kinship ties in the community (Nelson 1969, Alaska Consultants, Inc. 1984). In addition, fish are a crucial resource when other resources are less abundant or unavailable and, over time, fish are a more reliable and stable resource (Nelson 1969). Fuller and George (1992) estimated that fish resources made up 8.8 percent of the total subsistence harvest in 1992. The community noted that recently there seems to be more salmon in local rivers. Historically, chum salmon was the only variety caught, but recently people have reported catching king, chum, Coho, and sockeye (Kassam and Wainwright Traditional Council 2001).

Wainwright's caribou harvest area centers around the community, the Kuk River, and the river's tributaries (Map 3.4.3-7). Between 1962 and 1982, the annual caribou harvest averaged about 1,200 animals (Stoker 1983), accounting for 51.6 percent of the total annul subsistence harvest. Caribou are available throughout the year, with a peak harvest period from August to October. In Braund's 1989 study in Wainwright, caribou made up 21.3 percent of the total harvest, and in 1990 they composed 23.7 percent of the total harvest. In 1992, 748 caribou were harvested, representing 34.3 percent of the annual subsistence harvest (Steven R. Braund and Associates 1991, Steven R. Braund and Associates and Institute of Social and Economic Research 1989 and 1993, Fuller and George 1997). Hunters contend that over the last 50 years, caribou have become tamer and many do not migrate, instead spending the entire year in the Wainwright area (Kassam and Wainwright Traditional Council 2001). From 1962–1982, Wainwright residents annually harvested an estimated 1,200 pounds of birds, which constitutes approximately 0.3 percent of the total annual subsistence harvest (Stoker 1983). In 1989, Braund reported that birds were 2.4 percent of the total harvest and geese were 2.0 percent of the total bird harvest; in 1990, birds were 2.1 percent of the harvest (Steven R. Braund and Associates 1991, Steven R. Braund and Associates and Institute of Social and Economic Research 1993). Although the volume of waterfowl meat is a relatively small portion of the total subsistence harvest, waterfowl hunting is a key element in Wainwright's subsistence routine. Like fishing, bird hunting is highly valued in social and cultural terms. Waterfowl dishes are an essential part of community feasts prepared for holidays such as Thanksgiving and Christmas (Nelson 1969). Fuller and George (1992) estimated that birds made up 4.5 percent of the total subsistence harvest in 1992. Table 3-30 shows the most representative subsistence harvest data for Wainwright.

Table 3-30. Most representative subsistence harvest amounts for Point Lay and Wainwright, Alaska

	Point Lay, 1987			**Wainwright, 1992**		
Resource	**Total pounds harvested**	**Household harvest (lbs)**	**Per capita harvest (lbs)**	**Total pounds harvested**	**Household harvest (lbs)**	**Per capita harvest (lbs)**
Bowhead whale *Aġviq*	0	0	0	102,132[1]	858.25	218.23
Beluga Whale *Qiļalugaq*	64,929	1,509.98	538.52	32,321	213	55
Pacific Walrus *Aiviq*	4,603	107.4	38.18	63,614	419	109
Bearded Seal *Ugruk*	2,341	54.44	19.42	28,005	184	48
Other Seal *Natchiq/Qasigiaq*	4,391	100.44	35.82	6,815	57	12
Polar Bear *Nanuq*	661	15.38	5.48	1,663	14	3
Caribou *Tuttu*	18,418	428.33	152.76	87,514	576	150
Moose *Tuttuvak*	2,464	57.31	20.44	625	5.21	1
Small Land Mammals[2]	117	2.72	0.97	35[3]	0.04	--
Birds and Eggs	5,836	135.73	48.40	11,480	76	20
Fish	2,983	69.38	24.74	22,441	148	38
Vegetation	223	5.19	1.85	393	3	1

1. Bowhead harvest numbers are from 1989 (Alaska Department of Fish and Game Community Profile Database), as no bowheads were harvested from Wainwright in 1992.
2. Small mammals include those harvested for food (hare, ground squirrel, porcupine, etc.) and for fur.
3. This number does not reflect furbearers, as only edible small mammal species were recorded by the North Slope Borough.

Sources: Alaska Department of Fish and Game 1996, Fuller and George 1997.

Subsistence Use Areas

Subsistence users from Wainwright primarily concentrate their efforts along the Utukok, Kokolik, and Upper Kuk tributaries, including the Iviasruk, Koalik, Ketik and Avalik rivers, and along Carbon Creek, all located in the northwestern NPR-A. The ability to hunt and fish along the upper reaches of these waterways during the summer depends primarily on the condition of the river channel and the amount of flow. White-fronted geese are hunted in May by snowmachine when rivers are still frozen, and nonbreeding and failed breeding brant are harvested in the latter part of June along the coast. Fall time caribou hunting is also primarily river based, and takes place during August–October. Hunting caribou from along the river allows for the easy transport of the meat back to the village by boat. Fishing activity along the waterways can take place all summer from July to September, but it is thought that fish taste better in the fall. Upriver fishing occurs in late August by way of nets during the evening, with the focus on harvesting grayling, whitefish, burbot, lingcod and Dolly Varden (Kassam and Wainwright Traditional Council 2001).

During the winter and spring months, harvesting is facilitated by the ability to use snowmachines for overland travel. Residents from Wainwright frequently travel into the DeLong Mountains for furbearer and caribou hunting. Caribou are sporadically located across the North Slope all winter long, and many hunters plan a combined furbearer and caribou hunting trip to acquire fresh meat during the winter months. Caribou hunting also takes place in late April, before the snow cover and ability to travel by snowmachine is over, in order to have a store of caribou meat during the summer months (Schneider and Bennett 1979). The primary furbearers targeted during the winter are wolverine and wolf, with arctic fox and red fox harvested closer to the community in the springtime.

Point Lay

The community of Point Lay, the smallest in the North Slope Borough, is located approximately 90 miles southwest of Wainwright, 26 miles west of the western boundary of the planning area, and is positioned where the Kokolik River empties into Kasegaluk Lagoon. In 1990, the population of Point Lay was 139 and the 2000 census counted 247 residents, representing a 44 percent increase in population (Department of Commerce, Bureau of the Census 1991 and 2001). Point Lay's subsistence-harvest area is shown on Map 3.4.3-8. Subsistence resources used by Point Lay are listed by common species name and Iñupiaq name in Table 3-30. The Point Lay seasonal subsistence round, shown in Table 3-31, is dominated by a community-wide cooperative beluga whale harvest that occurs in late June or early July (Bacon et al. 2009).

Table 3-31. Annual cycle of subsistence activities, Point Lay

Species	Winter					Spring		Summer			Fall	
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Fish	▒							▒	▒	▒	■	■
Birds/Eggs						■	■	■	▒	▒	▒	
Berries								▒	▒	■	■	
Moose								▒	▒	▒		
Caribou	▒	▒	▒	▒	▒	▒	▒	▒	■	■	■	■
Furbearers	■	■	■	■	■	▒	▒					■
Polar Bear	■	■	■	■	■	▒	▒					■
Seals	▒	▒	▒	▒	▒	■	■	▒	▒	▒	▒	▒
Walrus						▒	▒	■	■	■	▒	▒
Beluga						▒	▒	■	■	■		

	No to very low levels of subsistence activity
▒	Low to medium levels of subsistence activity
■	High levels of subsistence activity

Source: Pedersen 1979

Seasonal Round

Point Lay residents enjoy a diverse resource base that includes both marine and terrestrial animals. Point Lay is unique among the communities in that, unlike the other communities discussed here, local hunters did not pursue the bowhead whale for a period of 72 years until the community was recognized in 2008 by the Alaska Eskimo Whaling Commission as the eleventh Alaskan bowhead whaling community and allowed a quota of one whale. The community successfully hunted a bowhead whale in the spring of 2009. Despite this new bowhead hunt, beluga whale is the village's pivotal marine mammal resource. Barrier island shores and the protected and productive lagoons they form provide prime habitat for sea mammals and birds, both of which are important resources harvested by Point Lay during their annual subsistence round (USDOI BLM 1978d, Fuller and George 1997).

In spring, ground squirrel and wolverine come out of hibernation and they are actively hunted; grizzly bear are sometimes taken in spring as well. Late summer is the best time for berry picking; mussels, clams, and other invertebrates are also gathered at this time. With the onset of winter, trapping and hunting for fox, wolverine, and wolf begins.

Fish is a valued resource in the subsistence economy. Fishing and time spent at fish camps is an important community activity for Point Lay residents. The most intense marine fishing with set gill nets starts in July and peaks in August. Chum, pink, and king salmon (rarely) are caught, as well as herring, smelt, flounder, Arctic char, grayling, and broad whitefish. In the fall, people move up the Kukpowruk and Utukok Rivers in family groups to fish camps where they net fish. When the ice hardens in the fall, they turn to jigging. Marine fishing takes place on the sea and lagoon shores of the barrier islands and along the mainland coast from Icy Cape to the south end of Kasegaluk Lagoon. Intensive use areas are found at Naokok Pass, near the old village, and on the shores near the present village site. For Point Lay's 1987 Subsistence-Harvest Summary, see Table 3-30 (Alaska Department of Fish and Game 2001).

Point Lay's most important subsistence marine resource is the beluga whale and the community depends on this species more than any other Native community in Alaska. Beluga whale makes up more than 60 percent of the community's total annual subsistence harvest (although precise data is unavailable, the percentage is certainly different for 2009 when the bowhead was caught). A major community activity is a single cooperative hunt in the summer, principally in the first two weeks of July, on the outer coast of the barrier islands. Hunting is done in a few key passes between these islands where schools of belugas migrating north are known to feed, and within Kasegaluk Lagoon. Most hunting is concentrated south of the village in Kukpowruk and Naokok passes. Beluga is shared with other communities and may be exchanged for other subsistence foods hard to come by in Point Lay.

In the early 1970s, when resettlement occurred, caribou was Point Lay's single most important subsistence food source. In the intervening years, however, beluga whales have supplied the greater amount of food. After beluga hunting, caribou hunting has the next highest participation percentage for the community. Hunters prefer to hunt caribou in late summer and fall, during the months of August, September, and October, when the animals are fat and the males have yet to rut. Caribou are also available in winter and are frequently taken opportunistically during furbearer hunting and trapping.

Migratory birds (and their eggs) are an important food source for Point Lay residents, supplying them with their first source of fresh meat when ducks and geese migrate north in the spring. Eider ducks and geese migrate coastally while other types of geese follow major river drainages. Hunting is usually done from the edge of the spring ice leads during May when hunters are looking for seals. In late August and early September, geese are again hunted as they fly south.

Subsistence Harvests

Table 3-30 represents harvest information for Point Lay derived from harvest surveys during 1987 by the State of Alaska. In recent years, a few Point Lay men participated in the bowhead whale hunt by traveling to Point Hope, Barrow, and primarily Wainwright, to whale with local bowhead whaling crews (Impact Assessment, Inc. 1989). Until 2008, bowhead whaling was not practiced in Point Lay for several reasons but primarily because spring ice leads are usually too far offshore of the barrier island/lagoon environment of the community. The unique environmental challenges presented by the physical setting at Point Lay kept bowhead whaling from appearing in the more modern seasonal subsistence round. Bowhead whales were taken traditionally, but there had not been a bowhead taken in the village since it was resettled in 1972. In fact, no bowheads had been taken in the area since 1941 (Braund et al. 1988, Impact Assessment, Inc. 1989).

In 1983, the beluga harvest was reported to range from 3 to 30 whales annually, with a mean annual harvest of 13 (Davis and Thompson 1984). In 1982, Point Lay harvested 28 belugas (Braund and Burnham 1984) and in 1992 the estimated harvest was revised upward to 40 whales annually from 1983 to 1992 (Fuller and George 1997). Between July 1994 and June 1995, the estimated harvest of belugas was 33. Between July 2002 and June 2003 there was an estimated harvest of 31 belugas. An average of 38.4 belugas were taken per year by Point Lay between 1990 and 2005 (Bacon et al. 2000).

Other important subsistence marine mammal resources include walrus, ugruk (bearded seal), ringed seal, and polar bears. Between 1987 and 2005, Point Lay harvested an average of 3.6 walrus per year with a high of 11 and a low of zero (Bacon et al. 2009).

Eider and oldsquaw are the most hunted ducks, while brant and Canada geese are the primary geese species. Ptarmigan can be taken all year and, like caribou, are available during the winter months. For Point Lay's 1987 Subsistence-Harvest Summary, see Table 3-30; for harvest seasons, see Table 3-31 (USDOI BLM 1978d, Braund and Burnham 1984, Alaska Department of Fish and Game 2001).

When caribou populations plummeted in the 1970s and strict harvest regulations were imposed, the community had difficulty making dietary adjustments; it could not rely on bowhead whales because of limited accessibility, or on the area's limited fish resources (streams and rivers in the area are small and only marginally important in terms of area fish production [Craig 1984]). An estimated 223 caribou were taken between July 1994 and June 1995 and 154 between July 2002 and June 2003. Other terrestrial mammals harvested included brown bear, wolverine, a wolf, and ground squirrels. For Point Lay's 1987 Subsistence-Harvest Summary, see Table 3-30; for harvest seasons, see Table 3-31 (USDOI BLM 1978d, Alaska Department of Fish and Game 2001, Fuller and George 1997).

Arctic grayling and salmon are especially important fish resources for Point Lay. Arctic grayling are primarily caught by jigging through the ice in the autumn and salmon are primarily caught in gill nets set in the lagoon or occasionally in the ocean. “Trout” are also taken at Point Lay, these fish are likely arctic char, as well as arctic flounder. The estimated total harvest during July 1994 to June 1995 for Point Lay included 94.9 arctic char, 567.3 arctic grayling, 468.9 salmon (all species), and 1,000 arctic flounder (Bacon et al. 2009). The estimated total harvest during July 2002 to June 2003 for Point Lay included 54 arctic char, 1,511 arctic grayling, 173 salmon (all species), and 12 arctic flounder (Bacon et al. 2009).

Subsistence Use Areas

In the past, Point Lay residents were the Kukparungmiut (people of the Kukpowruk River) and the Utukamiut (people of the Utukok River). These origins continue in the persistence of an important traditional use practice that takes subsistence hunters inland, up the Kukpowruk and Utukok Rivers. Within the boundaries of the planning area, hunters and fishers from Point Lay primarily concentrate their efforts along the Kokolik and Utukok rivers, and along Carbon Creek. Hunting efforts include springtime waterfowl harvesting of geese and ducks that follow river systems north and are found along the riverbanks during May, a time that can be risky for travel depending on ice and snow conditions (Schneider and Bennett 1979). Fall-time caribou hunting is also primarily river based, and takes place during August and September. Hunting caribou from along the rivers allows for the easy transport of the meat back to the village by boat. Fishing activity along the waterways can take place all summer from July to September, with most upriver efforts focusing on grayling and lake trout (Kassam and Wainwright Traditional Council 2001) Point Lay’s subsistence harvest area for beluga whales and other marine mammals extends from the south side of Cape Lisburne to the north side of Icy Cape (USDOI MMS 2008).

During the winter months, travel throughout the planning area is facilitated by the ability to use snowmachines for overland travel. Residents from Point Lay frequently travel into the De Long Mountains for furbearer and caribou hunting. Caribou are sporadically located in the planning area during winter, and many hunters plan a combined furbearer and caribou-hunting trip to acquire fresh meat during the winter months. Caribou hunting also takes place in late April, before the snow cover and ability to travel by snowmachine is over, in order to have a store of caribou meat during the summer months (Schneider and Bennett 1979). The primary furbearers that are targeted by hunters in the planning area during the winter are wolverine and wolf, with arctic fox and red fox harvested closer to the community in the springtime.

Other Community Use of the NPR-A

Several other communities also utilize the planning area, but only for a particular resource. A review of subsistence harvest area maps from the 1980s indicates that the planning area includes the periphery of subsistence use for the communities of Ambler, Kiana, Kobuk, Noatak, Noorvik, Selawik and Shungnak, all of which are located south of the NPR-A and within the Northwest Arctic Borough (Schroeder et al. 1987). Both reports that accompany the maps stress that the lines delimiting the community harvest area represent the outer boundaries of the areas used by subsistence hunters, and are fluid boundaries that can change from year to year as resource populations fluctuate their movements. Unfortunately, recent maps of community land use do not exist, therefore, the information from the 1970–80s is the best available at this time.

The use of the NPR-A by the above communities occurs during the winter, when traveling long distances is possible, and, therefore, is primarily focused on winter furbearer and caribou hunting. For none of the above communities does the planning area comprise the primary harvest area for caribou., Caribou harvest occurs during the fall and is focused along rivers, due to the ease in transporting meat back to communities by boat (Schroeder et al. 1987, Georgette and Loon 1988, Fuller and George 1997, Georgette 2000, Magdanz et al. 2004). Instead, the planning area comprises the outer limit to which subsistence hunters have traveled to harvest wolverine, wolf, and caribou during the winter months.

Subsistence Use of the Western Arctic Caribou Herd

As described in section 3.3.6 of this document, the planning area comprises the primary range of the Western Arctic Caribou Herd during the calving and summer insect-relief seasons. The current estimated population of the Western Arctic Caribou Herd is 325,000, making it the largest caribou herd in Alaska. As a result, it is also the most utilized herd for subsistence. The Alaska Department of Fish and Game Subsistence Division has collected sporadic information on the subsistence harvest of the Western Arctic Caribou Herd for 32 communities (Alaska Department of Fish and Game 2001), but it is estimated that at least 43 rural communities use the Western Arctic Caribou Herd and for some it is their primary terrestrial meat source. As a result, any activity that threatens the viability of the herd has profound consequences for the communities that live within or near its overall range. Only rough estimates for the total number of caribou harvested from the Western Arctic Caribou Herd by subsistence users is available, and is approximately 14,000 caribou for 2002–2003 and 11,000 caribou in 2003–2004 (Dau 2005).

The following is a list of the communities who use the Western Arctic Caribou Herd:

Barrow
Kivalina
Atqasuk
Ambler
Brevig Mission
Kobuk
White Mountain
Unalakleet
Grayling
St. Michael
Galena
Wainwright
Kotzebue
Anaktuvuk Pass
Shungnak
Council
Deering
Golovin
Kaltag
Stebbin's
Nulato
Ruby
Point Hope
Noorvik
Noatak
Selawik
Nome
Wales
Shaktoolik
Koyukuk
Alatna
Huslia
Bettles/Evansville
Nuiqsut
Point Lay
Kiana
Shishmaref
Elim
Teller
Koyuk
Hughes
Buckland
Allakaket

During scoping meetings held in 2005 in communities that utilize the herd, concerns about potential impacts to the Western Arctic Caribou Herd dominated discussions about subsistence. An elder from the community of Kivalina stated that the land used by caribou in the planning area was "our dinner table," referring to the importance of having a stable and healthy population (USDOI BLM 2005). Other communities asserted that any impact to the herd would result in an impact to their subsistence way of life.

3.4.3.4 Subsistence User Avoidance of Developed Areas

Following the reestablishment of Nuiqsut in the Colville River Delta in 1973, community residents re-familiarized themselves with the subsistence resources of the area based on the knowledge of elders who had remained in the area or continued to use the area while living in other communities. Their subsistence harvest and use areas are documented in "Nuiqsut Paisaŋich" in a series of maps (Brown 1979) created by the North Slope Borough as part of its program of traditional land use documents (Hoffman et al. 1988), and by Pedersen (1979, 2006). In 1973, oil development was some distance from the community, but its impacts were felt by residents who had ties to the developed area and by residents who wished to use subsistence areas on the east side of the developed area (Brown 1979). These issues and concerns were documented in the early 1980s by researchers working under contract to USDOI Minerals Management Service for the Social and Economic Studies Program (Institute of Social and Economic Research 1983). The Institute of Social and Economic Research (1983) report documented the high potential for conflict between Iñupiaq subsistence uses of the land and industrial activities. The report also outlined the actual conflicts and concerns between Iñupiaq subsistence uses and industry (Institute of Social and Economic Research 1983). No other community in Alaska is as close to intensive oil exploration, development, and production as Nuiqsut. This proximity is reflected in residents' increased concerns about reduced subsistence access through increased regulations, competition with outsiders, and the imposition of physically obstructive facilities in traditional use areas (Institute of Social and Economic Research 1983).

Through the 1980s, the industrial developed area expanded west from Prudhoe Bay, and the possibility of offshore development near Nuiqsut was impending (Impact Assessment, Inc. 1990a). By 1985, development encompassed subsistence and traditional use areas from Oliktok Point south along the Kuparuk River (Pedersen et al. 2000). The harvest of marine resources at specific locations was complicated or prevented by onshore development at traditional camps (e.g., Oliktok Point, Niakuk) and by offshore activity (e.g., drilling, seismic testing, and sealift) (Pedersen et al. 2000).

By 1990, Galginaitis wrote in the USDOI Minerals Management Service "Social and Economic Studies Special Report 8" that "Perhaps the most obvious effect of oil development in the Nuiqsut area has been that it has effectively removed certain areas from the Nuiqsut subsistence land use area" (Impact Assessment, Inc. 1990a). Subsistence users' reasons for avoiding or not avoiding areas in response to oil development in the late 1980s were similar to those noted in the 1983 Institute of Social and Economic Research study and included regulatory constraints, cultural prohibitions from using developed areas, lack of cultural privacy, notice or belief that a resource is contaminated, and physical obstacles and barriers such as low pipelines and steep gravel road side-slopes (Institute of Social and Economic Research 1983, Impact Assessment, Inc. 1990a).

Nuiqsut subsistence use areas retreated from the east as development moved westward from Prudhoe Bay to Oliktok Point, particularly in the area of the Kuparuk River Unit field. Onshore development displaced subsistence uses east of the Colville River for the majority of Nuiqsut users, and the few who continued to use the area did so primarily for political purposes and did not take many caribou there (Impact Assessment, Inc. 1990b). By 1990, Nuiqsut community members were concerned that development would continue to encroach on their shrinking subsistence and traditional use areas on the Itkillik and Colville rivers and the Colville Delta (Impact Assessment, Inc. 1990b). At that time, some hunters noted that further development in these subsistence use areas would impose a severe hardship on the community of Nuiqsut (Impact Assessment, Inc. 1990b). Isaac Nukapigak, subsistence hunter and President of Nuiqsut's Kuukpik Corporation, affirms that Native subsistence hunters harvest virtually no game within a 5-mile radius of oil and gas facilities and dramatically reduced amounts of game harvested within a 16-mile radius (Nukapigak 2012).

In 1993, development activity was encroaching on valued traditional use areas and onshore subsistence harvests and uses in industrial areas north and east of Nuiqsut declined to near zero (Pedersen et al. 2000). Whaling at Cross Island, the use of onshore camps, and storage of the bowhead harvest at Oliktok Point became deeply entwined with oil company personnel and oversight, as companies sought to minimize the time spent by Iñupiaq hunters in the developed areas and to avoid attracting polar bears to Oliktok Point by shipping whale meat and maktaq by air to Nuiqsut. This assistance provided some advantages to subsistence users because it was convenient and saved them time; however, it also reduced the autonomy of the hunters and subjected them to scrutiny and regulation throughout the whaling process, which resulted in a lack of cultural privacy (Pedersen et al. 2000).

Nuiqsut caribou harvests within the developed areas in 1993 were at or near zero. Four percent were within 5 miles of developed areas, 17 percent were harvested from 6 to 15 miles, and 79 percent were harvested more than 16 miles from development. The 1994 caribou harvest data were similar in terms of the percent of caribou harvested in relation to harvest proximity to development. Key informants noted in a 1998 Nuiqsut group session that they no longer used the developed area northeast of Nuiqsut as intensively as they had in the past because of difficulties in accessing the area, lack of privacy, loss of cultural landmarks, uncertainty regarding regulations, and oil field security enforcement (Pedersen et al. 2000).

For the study years reported in Pedersen et al. 2000 (i.e., 1993 and 1994), harvest locations and amounts for caribou are consistent with the published and unpublished harvest location data from the North Slope Borough Division of Wildlife Management for 1994–95, 2000, and 2001 (Brower and Hepa 1998, North Slope Borough 2003). Both sets of data support the finding that Iñupiaq subsistence users harvest most of their caribou in locations that are distant from developed areas east of the Colville River. This shift applies to most other subsistence resources as well.

Pedersen and Taalak (2001) conducted a survey of Nuiqsut households during June 1999 through May 2000. Caribou were the most widely used terrestrial big game resource in Nuiqsut, with an average of four caribou per household when averaged for all community households. According to their report, 75 percent of the 371 caribou harvested by Nuiqsut hunters from June 1999 through May 2002 with known harvest locations were harvested west of Nuiqsut, 11 percent were harvested in the immediate vicinity of the community, and only 14 percent were harvested to the east. Seventy-eight percent of all known caribou harvests occurred away (6 to 16 or more miles) from oil production facilities in 1999–2000. Twenty-two percent were reported harvested in peripheral areas (0 to 5 miles) to development, and there were no reports of harvests during this time period inside the industrial developed area. In general, these findings are consistent with the earlier conclusions for the 1993 and 1994 caribou harvests (Pedersen et al. 2000). However, the 1999–2000 caribou harvests classified as distant (more than 16 miles) from oil development dropped to 51 percent, compared to 79 percent in 1993 and 77 percent in 1994. This reduction is the result of oil development (Alpine field) moving west into the Colville Delta, an area of focused Nuiqsut caribou harvests, especially during June through September.

The Alpine development is too recent and there are insufficient data available to conclude whether harvesters will increase their distance from development in response to this relatively new facility. Furthermore, in 1999–2000, the Alpine field footprint was relatively small compared to larger development east of the Colville River, and ConocoPhillips Alaska, Inc. has made efforts to work with Nuiqsut to accommodate hunters.

Based on data from Pedersen et al. (2000) and Pedersen and Taalak (2001), as a consequence of oil development, Nuiqsut caribou harvesters tend to avoid development, with approximately 78 percent of the 1993 and 1994 caribou harvests occurring greater than 16 miles from the development east of the Colville River. In addition, 51 percent of the 1999–2000 harvests occurred greater than 16 miles from the Alpine field development, while 27 percent occurred 6 to 15 miles from the Alpine field development.

Further development anticipated in Pedersen et al. (2000) has come to pass with the development of Alpine, Meltwater, Tarn, Fiord, and other oil fields in the vicinity of Nuiqsut. This ongoing development has contributed to a feeling of being "boxed in" for Nuiqsut subsistence users (Pedersen et al. 2000).

3.4.3.5 Subsistence and Climate Change

The impacts of global climate change are more acute in the western Arctic than in most regions of the world, and changes to the environment and habitats of the North Slope resulting from climate change are affecting subsistence resources and resource users (Alaska Climate Impact Assessment 2004). North Slope communities are adjusting to the impacts of climate change, including changes to species diversity, numbers, and distribution of Arctic-adapted species, vegetation coverage and type, and the physical structure of the landscape itself. Erosion of riverbanks and beach bluffs, resulting from the thawing of permanently frozen ground, is affecting how subsistence practices are undertaken as cabins and camps continue to be washed away. Climate change is resulting in a reduction in marine ice and a less safe ice edge, affecting spring marine mammal hunting, including Barrow spring bowhead whale hunting, polar bear hunting, and seal hunting (Reiss 2010). Rising sea levels are inundating some low-lying coastal lands along the North Slope and changing the salinity of surface and ground water, further changing subsistence resource uses. Any discussion of climate change and its impacts involves a high degree of uncertainty and there is no method of accurately predicting future scenarios. Also unknown is the degree to which the Iñupiaq subsistence system will be able to transform and adapt to changes. What is known is that the Iñupiat have successfully adapted to significant changes several times in recent history and are opportunistic and resourceful subsistence users who are already adjusting to the environmental effects that climate change has caused to date. The impacts of climate change vary widely from location to location within the planning area, and the following brief examples do not hold true for the entire NPR-A.

Access

Climate change could create harvest disruptions either due to the resource changing its migration schedule or due to weather conditions preventing hunters' access. For example, most North Slope hunters make an effort to hunt caribou in the fall before the males go into rut. In the past, the ground and smaller rivers and lakes would usually freeze around late September before the males would go into rut, making it feasible to hunt by snowmachine. In recent years, hunters are faced with the possibility that the land and water can freeze and thaw out several times before freezing for the winter, making it difficult to travel long distances (e.g., a hunter takes a boat and the water freezes far from town, or a hunter takes a snowmachine or four-wheeler and the water thaws far from town). In general, travel across much of the North Slope is most efficient by snowmachine, and uncertain travel can be particularly difficult in the fall when people are trying to put up caribou. Continued warming in NPR-A may exacerbate this situation for some years, at least until approximately the middle of the century when rivers will likely remain unfrozen into October (Scenarios Network for Alaska Planning 2010).

Species

A commonly observed impact of climate change in some parts of the planning area is an increase in the number of plant, animal and insect species appearing. Residents have reported fish from warmer, southern waters appearing in their fishing nets, and that there is a proliferation of insects, including flies that make caribou sick. Some residents have recently purchased bird guidebooks to identify the numerous species of birds appearing that they do not recognize (Reiss 2010). Climate changes may be reducing suitable browse for caribou and muskoxen, possibly shifting their range away from the communities or reducing their numbers. The same habitat changes may favor moose, which Iñupiaq hunters perceive as less suitable as subsistence staples because they are solitary, require large ranges per animal, and do not predictably move in large numbers to specific areas, making it more difficult and energy intensive to harvest them. Due to their size, moose also require more effort to butcher, transport, and process than caribou and muskoxen (Alaska Climate Impact Assessment 2004).

Charles Ekak of Wainwright reports that he was very suspicious when he recently tried cooked porcupine for the first time. Ekak did not know the Iñupiaq word for porcupine because it is “not on the menu in the Iñupiaq world” and, according to Ekak, they have only been seen twice in Wainwright. Ekak said that the porcupine meat was delicious and very soft. He also noted that there is currently (November, 2010) a large herd (>30) of muskoxen north of Wainwright, between the community and the Kugrua River. He said that in the past, people have only seen one or two muskoxen at a time. Ekak said that Wainwright people are familiar with the use of muskox meat to feed dog teams. He has never eaten it and was not aware that Canadian Iñuit consider it a delicacy, but he is eager to try it. Ekak also reported that there were lynx in the Wainwright and Kuk River area when he was young, but that they have not been seen in that region until recently reappearing. There are also many more moose in the area than residents are accustomed to seeing (Ekak 2010).

Another recent change that is most likely connected to climate change is the northern advance of salmon berries on the North Slope. Salmon berries (akpik) are an important subsistence resource for many Inupiaq and Yup’ik communities in Alaska, but they have never been available in great quantities in the more northerly communities. In recent years, however, elders who have spent their entire lives living in Barrow have begun to see salmon berries in the region. According to Ekak, since about 2000 there have been rich patches of salmon berries in the immediate environs of Wainwright. Ekak remembers that there were hardly any salmon berries around Wainwright when he was growing up. Ekak also explained that since geese are avid consumers of salmon berries, especially before they migrate south, there have been large flocks of geese landing near town to eat the berries.

Ice Cellars

Across the North Slope, cellars dug into the permafrost have provided food storage for the Iñupiat for thousands of years. Ice cellars (siġluaq) use whale bones or driftwood for the frame, sod for the roof, and frozen ground for refrigeration. They have been efficient, economical, and have provided ample space to store many months’ worth of meat. A great deal of work is required to construct and maintain an ice cellar, and they are among a family’s most valuable assets. Coastal erosion, exacerbated by climate change, has resulted in the total loss of some ice cellars in the planning area. Over the last decade, the average air temperature has crossed a threshold and, in several locations within the NPR-A, the active layer is larger (the ground is thawing deeper than in the past) and the integrity of ice cellars has been undermined: some are partly thawed and some flood with melt water. If whale and other meats are stored in the cellar long before the temperature is low enough, spoilage can occur and the cellars can become an attraction for polar bears and other animals (Brubaker et al. 2009a). Bacterial growth on the meat can also lead to food-related illnesses (Brubaker et al. 2009a). The phenomenon of ice cellar degradation is reducing the quality and quantity of food available to subsistence users within the planning area.

Charles Ekak noted that ice cellars in Wainwright are not experiencing actual melting, but that the ground temperature is warmer and the food in them is not as cold as it used to be.

According to Ekak, this can improve the taste and texture of certain foods, but that others can become dangerous. People now try to enter and exit the cellars very quickly to avoid letting warm air in. He also noted that the more food there is in the cellar, the harder it is to keep it frozen. Ekak noted that people used to keep much more food in their cellars (up to half a year's worth), but that now people hunt enough for just a few days, freeze that, and go out hunting again. He also noted that ice cellars need to be deeper now to keep food frozen. The continued deepening of the active layer projected for the NPR-A (Scenarios Network for Alaska Planning 2010) is likely to exacerbate problems with ice cellars and increase the importance of steps such as those noted by Ekak.

Water

Fresh water is a critical resource on the North Slope, and tundra ponds across certain areas of Alaska have been shrinking as a result of increased evaporation and permafrost melting (Riordan et al. 2006), both of which are projected to continue through the end of this century (Scenarios Network for Alaska Planning 2010). Melting permafrost can allow perched water to dissipate, and higher temperatures cause a higher rate of evaporation. The loss of tundra ponds is a loss of fresh drinking water and nesting grounds for migratory birds (Reiss 2010). At the same time, thermokarst is creating or increasing the size of lakes in parts of the planning area.

Erosion and climate change may also be changing water levels in rivers and streams in some parts of the planning area, making transportation by boat and land more difficult, damaging or destroying infrastructure, and reducing water quality (e.g., turbidity, dissolved oxygen) until some waters are no longer suitable fish habitat. In some areas, water flow is increasing as glacier fed streams absorb melting runoff, which can also change water quality, fish habitat, and possibly damage the river valley microhabitats along the north-south oriented rivers of the North Slope.

Although water acquired through water treatment facilities is not considered a subsistence resource, the operation of those facilities is one method of documenting changes in the fresh water resources. In the summers of 2007 and 2008, Point Hope's fresh water source, 7 Mile Lake, was low and other tundra ponds in the vicinity dried up completely (Brubaker et al. 2009b). The quality of the water was also diminished, resulting in increased labor at Point Hope's water treatment plant in order to treat enough water to fill the community's tanks for the winter. The water being pumped to the treatment facility was warmer and there was an increased amount of biological slime and mosquito larvae in it, requiring filter bags to be changed more often (Brubaker et al. 2009b).

Charles Ekak attests to the fact that many of the large fresh water lakes that used to surround Wainwright have dried up in recent decades. He has looked into the bottom of those dried up lakes and seen large cracks in the ground through which the water drained. The smaller ponds evaporate by themselves, Ekak said. He believes that because of the new drainage systems occurring, fish can more easily migrate from one lake to another and that some lakes that used to freeze solid now do not and therefore support fish. He reports that people are now fishing in lakes that used to have no fish that are adjacent to lakes they used to fish in (Ekak 2010).

West Wind Storms

As has been observed across the western Arctic, fall storms are having a much greater impact on the coast than they did in the past because there is a longer period without shore-fast ice. While the most obvious impact of these storms is coastal erosion, the waves also wash plants, animals, artifacts, and other resources onto the shore. Several people in Barrow regularly beach comb, especially after large waves and in certain areas. In Wainwright, a recent west-wind storm washed up large amounts of coal on the beach. Although no one in Wainwright currently heats with coal, it is a traditional subsistence resource that is made more easily available by climate change. The same is true of driftwood, raw and milled, which is washed up on the beaches in greater amounts when there is no ice deflecting the waves. Driftwood, although not as valuable a subsistence resource today as it has been in the past, is still gathered for woodstoves and as an emergency heating material for search and rescue cabins. Another resource that is still collected by Wainwright residents is hardware from whaling ships that were shipwrecked on the coast in the 1870s. Charles Ekak reports that the recent fall storms have been washing up items from those ships that people have rarely seen for over 100 years. The main items people are eager to harvest are brass nails that are square, about 7 inches long, and still shiny and functional. Ekak also reported that a west wind storm in October, 2010, washed up "bushels" of whole, live clams, which were harvested, cooked, and eaten by the community. Ekak has no memory of clams being harvested in Wainwright before, although Barrow people used to harvest clams and no longer do so due to the erosion of the beach (Nageak 2010). The storms also wash up raw ivory, animal bones, starfish, mussels, and various sea plants around Wainwright (Ekak 2010).

3.4.3.6 Conclusion

Although changes in resource distribution, fluctuation in whale and caribou populations, epidemic disease, and prolonged contact with Euro-Americans have caused major changes in the geographic distribution and lifeways of the Iñupiat, the viability of the subsistence lifestyle continues to be the most essential issue on the North Slope. The most important subsistence foods on the North Slope are caribou, bowhead whale, and fish, and the subsistence diet is highly nutritious and protective against many common diseases.

Generally, communities harvest resources nearest to them, but harvest activities may occur anywhere in the planning area. Depending on their location, the six Iñupiaq communities that are within or near to the NPR-A depend more on certain animals than others: Barrow is more dependent on bowhead whales than other communities, while Anaktuvuk Pass is inland and depends almost entirely on caribou and sheep. Point Lay has always been highly dependent on beluga whales, while fish constitute a particularly high percentage of Nuiqsut's subsistence diet.

Subsistence hunting patterns and seasonal rounds are roughly the same with some variation depending on location and resources. Subsistence is at the core of Iñupiaq kinship systems and social networks, which are shaped by subsistence task groups and the sharing of subsistence foods. This sharing network extends across the North Slope and beyond: it is accepted by Iñupiat that Iñupiaq people cannot thrive without subsistence foods. Variety in resources and timing is a critical component of the wider subsistence system, because families and villages share large amounts of what they have most of with family in other communities, especially in times of need. Thus, all communities consume the resources and are invested in the viability of subsistence everywhere on the North Slope.

Subsistence foods are also a critical aspect of economics on the North Slope, where a mixture of subsistence and cash continues to be a system that serves families well. The unavailability of subsistence foods would therefore create serious nutritional and economic shortages for the Iñupiat, because most products available in stores are extremely expensive and lower in nutritional quality. Recognition of the critical importance of subsistence food is reflected by the preference for a rural priority for subsistence resources in times of need that is protected by federal law and specifically by section 810 of the ANILCA. Currently, the most serious threats to the viability of subsistence on the North Slope include the effective removal of harvest areas due to industrial development and the impacts of climate change.

3.4.4 Sociocultural Systems

A sociocultural system is a complex cultural structure consisting of a definable population within a determinable territory, characterized by shared and interrelated ways of life including beliefs, norms, values, and technologies, which are shared within the population and passed on from generation to generation. This system comprises the fundamental traditions, ideas, behavioral patterns, and tools that humans use to adapt to their surroundings, and forms the basis of each unique way of life and culture. The sociocultural system is characterized by a description of the cultural values, social organization, and political organization of the society.

The predominant sociocultural system in the planning area is that of the Iñupiat Eskimos, an indigenous people who have lived in the area for at least the past 2,000 years (Anderson 1984). Today, the Iñupiaq culture continues to flourish and succeed, despite over a hundred years of pressure in the form of continuous contact with mainstream American culture. The most important tribal interest connected to the planning area is the maintenance of the Iñupiaq culture, including "Iñupiat Ilitqusiat," which is a recognized list of Iñupiaq core values (Knowledge of Language; Knowledge of Family Tree; Sharing | Humility | Humor; Respect for Others; Love for Children; Cooperation | Hard Work; Respect for Elders; Respect for Nature; Avoid Conflict; Family Roles; Spirituality; Domestic Skills; Hunter Success; and Responsibility to Tribe) and the corresponding cultural revitalization program, and the protection of their subsistence way of life.

This section provides a profile of the sociocultural system that characterizes the Iñupiat, who comprise the indigenous inhabitants of and the largest ethnic population within the Northwest Arctic and North Slope boroughs. The sociocultural system of the Iñupiat is described and discussed in detail in the following environmental documents:

- "Liberty Development and Production Plan Final EIS" (USDOI MMS 2002)
- "Beaufort Sea Sale 170 Final EIS" (USDOI MMS 1998)
- "Beaufort Sea Oil and Gas Development Project/Northstar Final EIS" (U.S. Army Corps of Engineers 1999)
- "Beaufort Sea Sale 144 Final EIS" (USDOI MMS 1996a)

- "Beaufort Sea Sale 97 Final EIS" (USDOI MMS 1987a)
- "Chukchi Sea Sale 109 Final EIS" (USDOI MMS1987b)
- "Northwest NPR-A Final EIS/IAP" (USDOI BLM 2004b)
- "Alpine Satellite Development Final EIS" (USDOI BLM 2004a)
- "Chukchi Sea Planning Area Oil and Gas Lease Sale 193 Final EIS" (USDOI MMS 2007)
- "Beaufort Sea and Chukchi Sea Planning Areas Oil and Gas Lease sales 209, 212, 217, and 221 Draft EIS" (USDOI MMS 2008)
- "Northeast NPR-A Final Supplemental EIS/IAP" (USDOI BLM 2008).

The following description is augmented by information from current anthropological or social studies including USDOI BLM National Petroleum Reserve-Alaska 105(c) studies and other pertinent documents (USDOI BLM 1978a, 1978b, 1978c, 1979a, 1979b, 1979c, 1981, 1982a, 1982b, 1982c, 1983a, 1983b, 1983c, 1990, 1991; Schneider et al. 1980; Hoffman et al. 1988; Stephen R. Braund and Associates et al. 1993; Alaska Natives Commission 1994; Fall and Utermohle 1995; Alaska Department of Fish and Game 1996, 2002; USDOI Minerals Management Service 1996b, 1996c; Circumpolar Research Associates 2002; Poppel et al. 2007; Braund and Kruse 2009; EDAW, Inc./Minerals Management Service 2008, 2009).

3.4.4.1 Cultural Values

For centuries, survival in the Arctic has centered on the pursuit of subsistence foods and materials, and the knowledge needed to find, harvest, process, store, and distribute the harvest. The development of Iñupiat culture depended on passing on traditional knowledge and beliefs about subsistence resources. This knowledge included observations of game behavior, how to use those observations to successfully locate and harvest game, and how hunters and their families should behave to ensure successful harvests in the future. Other skills and knowledge handed down through the generations included a suite of tools, techniques, and strategies necessary to survive and thrive in the harsh Arctic environment (Spencer 1976). For the Iñupiat, subsistence and culture continue to be inextricably intertwined. 62 percent of North Slope Borough adults and 72 percent of Northwest Arctic Borough adults harvest, hunt, and fish for subsistence resources (Poppel et al. 2007).

The process of obtaining, refining, and passing on subsistence skill is fundamentally linked to the Iñupiat culture, which is based on interdependent family groups and a tradition of sharing harvested resources. Traditionally, Iñupiat cultural values focused on their close relationship with natural resources, specifically the proper respect and treatment of game animals in order to assure a continued harvest. Other cultural values include conflict avoidance, an emphasis on the community and its needs, and support of other individuals. The Iñupiat respect people who are generous, cooperative, hospitable, humorous, patient, modest, and industrious (Lantis 1959, Milan 1964, Chance 1966 and 1990).

Although there have been substantial social, economic, and technological changes in Iñupiat lifestyle, subsistence continues to be the central organizing value of the Iñupiat sociocultural system. The Iñupiat remain socially, economically, and ideologically loyal to their subsistence heritage, and North Slope residents voice this repeatedly at public hearings and in other forums (Kruse et al. 1983, Alaska Consultants, Inc. et al. 1984, Impact Assessment, Inc. 1990a and 1990b, Poppel et al. 2007, USDOI MMS 1994).

Cooperation in hunting and fishing activities also remains an integral part of Iñupiat life, and a major component of significant kin ties is the identity of those with whom one cooperates (Heinrich 1963). Task groups are still organized to hunt, gather, and process subsistence foods. Large amounts of subsistence foods are shared within and between communities, and the people one gives to and receives from are major components of what comprises significant kin ties (Heinrich 1963, Alaska Consultants, Inc. et al. 1984, Bodenhorn 1989, 2000). As discussed in the 2004 "Alpine Satellite Development Plan Final EIS" (USDOI BLM 2004d), the sharing of subsistence foods is essential to the maintenance of family ties, kinship networks, and community well-being. Disruption of subsistence harvest patterns could alter these cultural values and affect community social structure. For the system of sharing to operate properly, some households must consistently produce a surplus of subsistence goods. For this reason, the supply of subsistence foods in the sharing network is more sensitive to harvest disruptions than the actual harvest and consumption of these foods by the primary producer.

The cultural value placed on kinship and family relationships is apparent in the sharing, cooperation, and cooperative subsistence activities occurring in Iñupiat society. About 93 percent of North Slope Borough residents, for example, believe that traditional food is important or very important to maintaining indigenous identity (Poppel et al. 2007). Cultural values are also apparent in the patterns of residence, reciprocal activities, social interaction, adoption, political affiliations, employment, sports activities, and membership in voluntary organizations (e.g., Mother's Club, Search and Rescue) (AlaskaConsultants, Inc. et al. 1984). Barrow resident Beverly Hugo, testifying at public hearings for the Minerals Management Services' Beaufort Sea Sale 124 EIS, summed up Iñupiat cultural values this way:

> These are values that are real important to us, to me; this is what makes me who I am . . . the knowledge of the language, our Iñupiat language, is a real high one; sharing with others, respect for others . . . and cooperation; and respect for elders; love for children; hard work; knowledge of our family tree; avoiding conflict; respect for nature; spirituality; humor; our family roles. Hunter success is a big one, and domestic skills, responsibility to our tribe, humility . . . these are some of the values . . . that we have . . . that make us who we are, and these values have coexisted for thousands of years, and they are good values . . . (USDOI MMS 1996a).

For North Slope communities, bowhead whale hunting remains the center of Iñupiat spiritual and emotional life; it embodies the values of sharing, association, leadership, kinship, Arctic survival, and hunting prowess (Bockstoce et al. 1979, Alaska Consultants, Inc. et al. 1984). The importance of the whale hunt is more than emotional and spiritual. The organization of the crews does much to delineate important social and kin ties within communities and define community leadership patterns. The structured sharing of the whale harvest helps determine social relations within and between communities (Worl 1979a, Alaska Consultants, Inc. et al. 1984, Impact Assessment, Inc. 1990a). Structured sharing also holds true for caribou, fish, and other subsistence pursuits. In Iñupiat communities, the giving of subsistence foods does more than feed people: it bonds giver and receiver, joining them to a living tradition, and reinforces a feeling of community.

Today, this close relationship between the spirit of a people, their social organization and the cultural value of subsistence hunting may be unparalleled when compared with other areas in the U.S. where energy development is taking place. The continuing strong dependence on subsistence foods by the Iñupiat, particularly marine mammals and caribou, creates a unique set of potential effects from onshore and offshore exploration and development on the social and cultural system.

Integrity of Place

In traditional times, Iñupiat extended family groups named themselves for the areas they used, each of which occupied a specific region that included at least one permanent winter village. These autonomous groups have been variously called regional groups, tribes, societies, and nations in the anthropological literature (Burch 1975, 1980 and 1998; Ray 1984). Burch (1998) however, provides the most compelling rationale in referring to these prehistoric populations as nations, in that they (1) had dominion over separate territories, (2) regarded themselves as separate peoples, and (3) engaged each other in war and trade—all aspects that define them as analogous to modern nations.

Each Iñupiaq nation had its own unique designation, with most consisting of a territorial or place name designation coupled with the suffix "-miut," meaning "people of." For example, the Iñupiat who resettled Nuiqsut consider themselves Kuukpikmuit, people of the Colville River Delta. One strategy Iñupiat used to maintain their connection to their homelands before the resettlement period was to use summer and winter school vacations to go from Barrow out to their camps. These regional groups reestablished Northwest Arctic and North Slope Borough communities in order to ease access to places that were important subsistence and meeting places. The availability and use of modern transportation technology allowed continuous use when it was necessary to reside in a regional hub such as Barrow for education, health care, and/or employment (Brown 1979).

Many people continue to use or desire to return to camps and harvest locations used in traditional times. Iñupiat consider traveling "out on the land" to be the natural and preferred state of affairs, and many feel even a brief trip can be therapeutic and stress relieving (Impact Assessment, Inc. 1990a, b). Some residents preserved their camps by applying for Native allotments before the passage of the Alaska Native Claims Settlement Act, while others continue to use the land much as they had before Congress enacted the act and the ANILCA to address land ownership issues in Alaska. Maintaining these ties to traditionally used sites is a priority for residents of Iñupiat communities (Brown 1979).

3.4.4.2 Social Organization

The social organization of Iñupiat communities is strongly based on kinship. Kinship forms "the axis on which the whole social world turn(s)" (Burch 1975). Historically, households were composed of large extended families, and communities were kinship units. Today, there is a trend away from the extended-family household because of increased mobility, availability of housing, and changes in traditional kinship patterns. However, kinship ties in Iñupiat society continue to be important and remain a central focus of social organization. The social organization of North Slope Iñupiat encompasses not only households and families, but also wider networks of kinsfolk and friends. These types of networks are related through overlapping memberships, and are embedded in those groups responsible for hunting, distributing, and consuming subsistence resources (Burch 1970).

An Iñupiat household may contain a single individual or group of individuals who are related by marriage or ancestry (Bodenhorn 1988). The interdependencies among Iñupiat households differ markedly from those found in the United States as a whole. In the larger non-Iñupiat society, the demands of wage work emphasize a mobile and prompt workforce. While modern transportation and communication technologies allow for contact between parents, children, brothers, sisters, and other extended-family members, more often than not, independent nuclear households (father, mother, and children) or conjugal pairs (childless couples) form independent "production" units that do not depend on extended family members for the day-to-day support of food, labor, or income. In contrast to the non-Native culture, in the Iñupiat culture individual family groups depend on the extended family for support and provision of day-to-day needs (Magdanz et al. 2002).

Associated with these differences, the Iñupiat hold unique norms and expectations about sharing. Households are not necessarily viewed as independent economic units, and giving, especially by successful hunters, is regarded as an end in itself, although community status and esteem accrue to the generous. The sharing and exchanging of subsistence resources strengthen kinship ties (Nelson 1969, Burch 1971, Worl 1979b, Alaska Consultants, Inc. et al. 1984, Luton 1985, Bodenhorn 1989 and 2000, Chance 1990, Magdanz et al. 2002).

3.4.4.3 Characteristics of the Population

The North Slope Borough's local residents are predominately-indigenous Iñupiat Natives. Smaller numbers of other non-Native groups live permanently in the communities, many working for the school district. Barrow has a significant population of Asian residents who fill many service-industry jobs. Temporary work crews are often in communities for projects such as construction or Distant Early Warning-Line site remediation. The oil and gas industry workforces rotate on a regular schedule and are temporary worker/residents in the region but have very little contact with the communities. Similarly, the Northwest Arctic Borough has the same dichotomy, with the transient residents consisting of workers at the nearby Teck-Cominco Red Dog Mine. As temporary residents, industrial workers have minimal participation in the local economy, and their needs for all services are provided by industry. On the other hand, full-time residents of the region form the primary social structure and the local economy.

The North Slope has a fairly homogeneous population of 70 percent Iñupiat. The percentage in 1990 ranged from 92.7 percent Iñupiat in Nuiqsut to 61.8 percent Iñupiat in Barrow (U.S. Department of Commerce Bureau of Census 1991). The Northwest Arctic Borough had a total population of 6,113 in 1990, with 85 percent (5,209) of the population identifying themselves as Alaska Native.

In 2000, population counts were 247 for Point Lay, 546 for Wainwright, 228 for Atqasuk, and 4,581 for Barrow (U.S. Department of Commerce Bureau of Census 2000). The percentages in 2000 ranged from 89.1 percent Iñupiat in Nuiqsut to 64.0 percent Iñupiat in Barrow. In 2000, 5,450 (73.8 percent) North Slope Borough residents reported they were all or part Alaska Native or American Indian. Based on tribal data, at least 4,594 of the 7,385

North Slope Borough residents were Iñupiat. For the Northwest Arctic Borough, the 2000 census indicated a drop in the Alaska Native population, to only 80 percent of the total population.

Iñupiat society responded to early contacts with outsiders by successfully changing and adjusting to new demands and opportunities (Burch 1975, North Slope Borough Contract Staff 1979, Worl 1979a, National Research Council 2003). Since the 1960s, Arctic Alaska has witnessed a period of intense change, with the pace of change quickened by the area's oil developments (Lowenstein 1981). In the Prudhoe Bay/Kuparuk River industrial complex, oil-related work camps have altered the seascape and landscape, making some areas off limits to traditional pursuits such as hunting. Large capital improvement projects have dramatically changed the physical appearance of North Slope Borough communities. Social services in the North Slope Borough and the Northwest Arctic Borough have increased dramatically from 1970 to the present, with increased budgets and grants acquired by or through the Arctic Slope Native Association, NANA Development Corporation, and other nonprofit organizations, and village and regional tribal governments such as I Iñupiat Community of the Arctic Slope.

In 1970 and 1977, residents of North Slope villages were asked about their state of well being in a survey conducted by the University of Alaska-Anchorage Institute of Social and Economic Research (Kruse et al. 1983). The survey noted significant increases in complaints about alcohol and drug use in all villages between 1970 and 1977. The Survey of Living Conditions in the Arctic (Poppel et al. 2007) found that 51 percent of North Slope Borough residents had experienced alcohol or drug problems in the home as a child, 34 percent experience drug or alcohol problems in their homes today, and that 73 percent perceived alcohol abuse as a social problem for indigenous people in their community. Health and social-services programs have attempted to meet the needs of alcohol and drug-related problems with treatment programs and shelters for wives and families of abusive spouses with greater emphasis on recreational programs and services, yet a lack of adequate funding for individual city governments has hampered the development of these programs. In addition, declining revenues from the State of Alaska have seriously impaired the overall function of city governments. Partnering together, tribal governments, city governments, and the Borough government may be able to provide programs, services, and benefits to residents. Numerous Alaska Native communities have banned the sale of alcohol and many communities are continually under pressure to bring the issue up for a local referendum vote (North Slope Borough 1998, Alaska Division of Public Health 2010). All North Slope Borough communities are "dry" except Barrow, which is "damp" and has had an alcohol distribution center since 2000 (Alaska Division of Public Health 2010). Published studies have found that deaths by injury in small rural Native Alaska villages decreased when more restrictive alcohol laws were enacted and alcohol-related outpatient visits decreased in Barrow when the community was dry (Alaska Division of Public Health 2010).

The introduction of modern technology has tied the Iñupiat subsistence economy to a cash economy (Impact Assessment, Inc. 1990b). Nevertheless, industry-derived revenues help support a lifestyle that still is distinctly Iñupiaq; indeed, outside pressures and opportunities have sparked what may be viewed as a cultural revival (Lantis 1973). What exists in the communities of the North Slope is a dual economic system "in which a modern cash economy and traditional subsistence are interwoven and interdependent," and through which the culture adapts and perpetuates itself (USDOI BLM 1979a, North Slope Borough 1998). People continue to hunt and fish, but aluminum boats, outboards, and all-terrain vehicles now help blend these pursuits with wage work. Iñupiat whaling remains a proud tradition that involves ceremonies, dancing, singing, visiting, cooperation between communities, and the sharing of foods.

The baseline of the present sociocultural system includes change and strain. The very livelihood and culture of the Iñupiat have come under increasing scrutiny, regulation, and incremental alteration. Increased stresses on social well being and on cultural integrity and cohesion have come at a time of relative economic well being. For the North Slope Borough, negative impacts due to the decline in capital improvement projects funding from the state have not been as significant as once expected. The buffer effect has come mostly through the dramatic growth of the North Slope Borough's own permanent fund, the Borough taking on more of the burden of its own capital improvements, and its emergence as the largest employer of local residents. However, North Slope Borough revenues from oil development at Prudhoe Bay are on the decline, and funding challenges (and subsequent challenges to the culture) continue as the state legislature alters accepted formulas for North Slope Borough bonding and funding for rural school districts.

Local residents exhibit an increasing commitment to area-wide political representation, local government (the revitalization of the Indian Reorganization Act [IRA] tribal governments), the cultural preservation of such institutions as whaling crews and dancing organizations, and the revival of traditional seasonal celebrations. The North Slope Borough's Commission on Iñupiat History, Language, and Culture and the Maniilaq Association are important bodies for preserving Iñupiat heritage, from conducting elders conferences and other cultural activities to preserving oral histories and actively pursuing the repatriation of cultural artifacts and remains under the Native American Graves Protection and Repatriation Act (Kruse et al. 1983, Alaska Consultants, Inc. et al. 1984, USDOI Minerals Management Service 1994, 1995a, 1996a, and 1997, USDOI BLM 1997, North Slope Borough 1998).

Institutional Organization of the Communities

Institutional, legal, and economic power in the communities of the planning area is divided among several organizations that regularly compete and sometimes cooperate in the operation of local government and business. An associated trend in the communities is that, since many villages are very small, individuals often "wear many hats" and work for or serve on the boards of two or more organizations.

With the exception of Point Lay, which does not have an incorporated city government, all of the communities that utilize the planning area have a local municipal government ("city office") and a local tribal government, consisting of the Native Village Tribal Council. For example, the two local government offices in Wainwright include the City of Wainwright and the Village of Wainwright, each with their own responsibilities for the community. The city office is responsible for recreation, cemeteries, boats, harbors, and a few other local services. Social services such as child care, language revitalization programs, or elder councils, including any issue that has the potential to affect the tribe or the Iñupiaq culture, are the responsibility of the Native Village. These include issues about land, hunting, subsistence, livelihood, local research (biological and social), and other important social concerns like local hire, substance abuse, and the importance of maintaining traditional Iñupiat values. Although the Native Village's power is limited in part because it does not own land, it is the organization with the largest potential to benefit from its relationship with the federal government on matters such as land management decisions, government-to-government consultations, and access to tribal-specific federal funding.

Two regional governments are present in the planning area. The North Slope Borough, with its main offices in Barrow, was formed in 1972 and is the largest home rule borough in the country, comprising 86,000 square miles. The North Slope Borough consists of eight communities located north of the Brooks Range. The Northwest Arctic Borough, with its main offices in Kotzebue, was formed in June 1986, is a home rule borough and the local political subdivision of the State of Alaska. The Northwest Arctic Borough is comprised of 11 communities in northwest Alaska, has an 11-member assembly, a 7-member planning commission, and a 15-member staff. In both cases, borough formation has allowed the communities to work cooperatively to receive state funds for transportation infrastructure, telecommunications systems, and other services for the benefit of the people of the region. Although officially members of the North Slope Borough, some municipal services provided to Point Lay and Point Hope, such as healthcare, originate from the Northwest Arctic Borough.

The North Slope Borough provides most government services for the communities that might be affected by activity in the planning area. These services include public safety, public utilities (including water, sewer, airport, roads, and power), fire protection, and some public-health services. The North Slope Borough also plays a lead role in managing subsistence resources in the planning area, largely through the Fish and Game Management Committee that operates through the Borough's Department of Wildlife Management. Although the Borough's revenues have remained healthy and its own permanent fund account continues to grow as does its role as primary employer in the region, the North Slope Borough's future fiscal and institutional growth is expected to slow because direct Iñupiat participation in oil-industry employment has never been high and constraints on the statewide budget are growing (Kruse et al. 1983, Harcharek 1992, 1995).

The passage of Alaska Native Claims Settlement Act resolved land claims between the indigenous Alaska Natives, the State of Alaska, and the Federal Government. Under Alaska Native Claims Settlement Act, Alaska was divided into 12 regions, with each region having a for-profit corporation responsible for managing the land entitlement and money derived from Alaska Native Claims Settlement Act. A 13th corporation was also created for those Alaska Natives living outside of the state. Two regional corporations have ties to the planning area—the Arctic Slope Regional Corporation based in Barrow and the NANA Regional Corporation based in Kotzebue. The regional corporations in Alaska today are some of the most successful businesses in the state, holding diverse investment portfolios including properties such as hotels and apartment complexes, industries such as oil and gas and construction, and stocks and other capital investment.

Most of the communities with ties to the planning area also have a local for-profit village corporation. Village corporations are responsible for managing the land and money each individual community received with the passing of Alaska Native Claims Settlement Act, and are able to bid on contracts, create investments, and engage in other for-profit activities for their shareholders. Every Iñupiaq resident in 1971 qualified for 100 shares each of their regional and local village corporation. Dependent upon the past year's profit and the decision of corporation managers, local and regional corporations distribute dividends annually to their original shareholders or their heirs.

The two regional corporations also have an associated non-profit social services entity—the Arctic Slope Native Association in Barrow and the Maniilaq Association in the Kotzebue area. The non-profit organizations primarily provide health, social, and tribal services to the resident communities of the region, including educational and cultural preservation opportunities for regional shareholders. It should be noted that the regional corporations, village corporations, and regional non-profits are for the benefit of the indigenous shareholders of each region, not the populations at large. These are Alaska Native entities, created as a result of the land claims. The Maniilaq Association is also the largest employer of residents in the Kotzebue region.

Additional Alaska Native non-profit organizations that serve to represent a variety of indigenous issues are also located in the two regional centers of Barrow and Kotzebue, such as the Alaska Eskimo Whaling Commission, formed in 1977 to represent the whaling communities and protect and preserve the subsistence hunt of bowhead whales. Additional non-profit entities that are subsumed within the overarching regional nonprofits, such as the Eskimo Walrus Commission, the Beluga Whale Committee, or the Reindeer Herders Association, serve specific roles relative to maintaining the traditional way of life of Alaska Native residents.

3.4.5 Environmental Justice

"Environmental justice" is an initiative that culminated with President Clinton's February 11, 1994, Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," and an accompanying Presidential memorandum. The Executive order requires that each federal agency consider environmental justice to be part of its mission. Its intent is to promote fair treatment of people of all races and income levels, so no person or group of people bears a disproportionate share of the negative effects from the country's domestic and foreign programs. Specific to the EIS process, the Executive order requires that proposed projects be evaluated for "disproportionately high adverse human health and environmental effects on minority populations and low income populations."

The Environmental Protection Agency guidelines for evaluating the potential environmental effects of projects require specific identification of minority populations when either: (1) a minority population exceeds 50 percent of the population of the affected area; or (2) a minority population represents a meaningfully greater increment of the affected population than of the population of some other appropriate geographic unit, as a whole.

All North Slope communities have a majority Iñupiat population; the percentages in the 2010 census ranged from 93.1 percent Iñupiat in Atqasuk to 68.6 percent Iñupiat in Barrow. In 2000, 5,450 (73.8 percent) North Slope Borough residents reported that they were all or part Alaska Native or American Indian. Although the Census did not differentiate between Eskimo, Aleut, and Indian, it did ask for the individual's "Alaska native or American Indian tribe(s)." Based on tribal data, at least 4,594 (62.2 percent) of the

7,385 North Slope Borough residents were Iñupiat (see section 3.4.4, "Sociocultural Systems"). Based on the census data, the minority population in the North Slope Borough is well above the 50 percent threshold specified in the EPA guidelines, so it is appropriate to consider potential environmental justice issues in evaluating the effects of the planning area alternatives.

Personal income is the income received by people from all sources: private sector and government wages, salary disbursements, other labor income, farm and nonfarm self-employment income, rental income, personal dividend income, personal interest income, and transfer payments. Per capita personal income is the annual total personal income of the residents of an area divided by their resident population. Per capita personal income can be a measure of economic well being because the amount of goods and services that people can afford is often directly related to their personal income. Personal income estimates do not attempt to quantify the non-cash contributions of subsistence activities to the economic well-being of North Slope Borough residents.

Figure 3-10 on page 483 shows annual per capita personal income for residents of the North Slope, compared to that of Alaska residents as a whole, for 1969 through 2008. From 1975 through 1991 and from 1993 through 1996, per capita personal income of North Slope residents exceeded the statewide average, sometimes by as much as 50 percent. Starting in 1984, the real per capita income in the region began to decline and the gap narrowed. North Slope per capita income began a steep increase in 2005 that continues to the present.

Based on the per capita income data, the North Slope population would not qualify as a low-income community for environmental justice consideration. However, personal income data alone do not address the question of overall economic well-being and factors specific to the North Slope. For example, the average cost of living is much higher on the North Slope than in Anchorage, and, as noted above, many North Slope residents benefit from subsistence activities. Because environmental justice considerations are already triggered by the race/ethnicity threshold, it is not necessary to analyze the issue of income/economic well-being in greater detail for environmental justice purposes. A more extensive economic analysis of communities within the planning area is provided in section 3.4.11, "Economy."

During development of the NPR-A IAP/EIS, scoping meetings were held in the North Slope Borough communities of Anaktuvuk Pass, Atqasuk, Barrow, Nuiqsut, Point Lay, and Wainwright. An Iñupiat translator at these meetings facilitated participation of non-English speakers. Environmental justice considerations for the IAP/EIS will also be gathered through or facilitated by (1) NPR-A Subsistence Advisory Panel meetings representatives of North Slope tribal and local governments, (2) local radio broadcasts and notices in the North Slope newspaper of meetings and other means to contact the BLM with concerns, (3) follow-up meetings that include discussions specific to environmental justice concerns, and (4) combined Draft IAP/EIS public meetings/ANILCA 810 hearings in Anaktuvuk Pass, Atqasuk, Barrow, Nuiqsut, Point Lay, and Wainwright.

To better address the concerns of environmental justice populations, the BLM entered into a memorandum of understanding with the North Slope Borough making the Borough a cooperating agency for the NPR-A IAP/EIS. Through its role as a cooperating agency, the North Slope Borough will play a role in the drafting of this IAP/EIS, including coordination of scoping and Draft IAP/EIS comment meetings, developing alternatives and mitigation measures, and drafting the analysis of marine mammals and public health. Through their work as a cooperating agency, the North Slope Borough substantially enhances this plan's consideration of environmental justice issues.

Major concerns expressed through the scoping process include:

- Protecting Native Allotments, regular hunting and fishing camps, and cultural sites
- Reducing the number of overflights, particularly during prime hunting season
- Conducting baseline studies on subsistence resources to maintain their health and identify impacts
- Identifying and protecting important subsistence areas
- Protecting caribou migration routes
- Providing river setbacks or buffers to protect historic fishing sites
- Providing natural gas to local communities
- Including local people in the planning effort
- Creating strict and nonflexible stipulations for industry
- Improving oversight and enforcement of mitigation measures
- Assessing impacts to human health and means to mitigate impacts to health
- Involving local people in scientific studies of resources
- The economic benefits of oil and gas development to North Slope Borough communities

Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," requires the BLM to consult with Iñupiat tribal governments of the North Slope on federal matters that significantly or uniquely affect their communities. The EPA's environmental justice guidance of July 1999 stresses the importance of government-to-government consultation. As one way to foster tribal participation and mitigate exploration and development impacts in the planning area, the BLM created the Subsistence Advisory Panel in 1998. Representatives from the communities of Anaktuvuk Pass, Atqasuk, Barrow, Nuiqsut, Point Lay, Wainwright, representatives from the North Slope Borough and the Iñupiat Community of the Arctic Slope compose the Subsistence Advisory Panel. Since its inception, the Subsistence Advisory Panel has met numerous times in North Slope Borough communities, resulting in an ongoing dialogue that will guide the BLM in making decisions on future exploration and development activities in the NPR-A.

Throughout the development of land management plans and government-to-government consultation efforts, the BLM endeavors to maintain a holistic perspective on environmental justice concerns for the Iñupiat of the North Slope. A broad and long-term view allows all parties to focus on mitigating current conflicts with oil and gas or other activities while understanding that the historical context of environmental justice issues for recently colonized minority populations plays a large role in shaping those conflicts and the attitudes surrounding them.

3.4.6 Recreation

The NPR-A is a vast Arctic region with outstanding recreation opportunities. With its small resident population, costly access, lack of facilities, and few visitors, the area currently is underused and could support additional recreation in the future. Recreational use of the planning area represents only about 1 percent of total statewide outdoor recreation activities. The demand for outdoor recreation due to population growth in the lower 48 states and Alaska is expected to increase on public lands (Hall 2009).

The BLM requires a special recreation permit for commercial use, organized group activities or events, competitive use, and for the use of special areas; and recreation use permits for use of fee areas such as campgrounds and day use areas (43 CFR 2931.2). Typically BLM issues special recreation permits in the NRP-A for activities such as backpacking, hiking, boating, sightseeing, and guided hunting. In 2005, there were seven authorized special recreation permits in the planning area compared to ten in 2010. Three of the seven from 2005 are still operating in the area.

Each special recreation permit holder is required to submit a post use report at the end of their season of activity. The information collected includes dates of use, user days and amount of receipts collected. To date there have been no visitor surveys/studies conducted by the BLM of the planning area. At this time, the cost of conducting such surveys would outweigh the benefits.

3.4.6.1 Activities

A 2001 report found that outdoor recreation participation and consumption among Alaskans are higher than the rest of the United States and that they are predicted to continue to be so until at least 2021 (Bowker 2001). The report found that bird and wildlife viewing along with fishing were among the most frequent participation activities per capita. The report was not germane to any one particular spot in Alaska, but to Alaska as a whole. While research has not been conducted specific to the planning area, backpacking, hiking, boating, and sightseeing along with bird and wildlife viewing are among the prevailing types of recreation in NPR-A and along the Colville River, the lower portions of which are technically just outside the Reserve. The area's principal outdoor recreational activities are described in the following subsections.

Backpacking and Hiking

Due to the remoteness and limited access, little backpacking (overnight trip) or hiking (day trip) unrelated to subsistence activities presently takes place in the NPR-A. In 2010 there were six businesses that had authorizations to conduct guided backpacking trips in the NPR-A; 10 trips were conducted. Typically, the southern NPR-A and northeast along the Colville River portions of the NPR-A have the most use for this activity. The vast areas of tussocks and/or wet, boggy terrain throughout the coastal plain are all but impassable in the summer. Backpacking and hiking also occur in the major river valleys in conjunction with float-boating activities. The backpacking/hiking season is short, generally from early to mid June to early September. There are no developed hiking trails. Access for backpacking is provided by aircraft using the larger lakes and river pools, gravel bars, or existing gravel runways as landing sites.

Boating

Very little recreational use (i.e., not related to subsistence) is made of the rivers and lakes in the NPR-A. In 2010, there were seven special recreation permit multi-day recreational float trips (10–12 persons per trip). There is no data for non- special recreation permit boating. Recreational guided boating of rivers takes place mainly on the Colville, Etivluk, Nigu and the Utukok rivers. Most of the boating is done with rubber rafts or folding kayaks to facilitate access by aircraft, which land on gravel bars or beaches, existing gravel airstrips, large pools on the rivers, or on lakes.

Generally, the opportunities for float boating on rivers in the planning area are not outstanding in comparison to similar opportunities offered elsewhere in Alaska. For example, none of the rivers in the area offers whitewater boating because most of the rivers have an insufficient flow of water during much of the summer. Some of the better boating rivers in the area are the Colville, Utukok, Etivluk, Nigu and the Ikpikpuk rivers. For more detail on rivers see section 3.4.7. Recreational boating is not practical on the many lakes and ponds in the Reserve as they tend to be very shallow.

Sightseeing

As quoted by Melissa DeVaughn's book, "The Unofficial Guide to Adventure Travel in Alaska," "The Far North is quintessential Alaska: long, cold winters, lots of dark nights, and plenty of wild animals roaming freely." The opportunities for sightseeing are immeasurable. Among wildlife viewing opportunities are the sightings of caribou, polar bears, brown bears, musk oxen, caribou, sheep, arctic fox, moose, peregrine falcons, as well as other raptors, including gyrfalcons, rough-legged hawks and golden eagles. The banks of the Colville River within the Reserve have one of the highest densities of nesting birds of prey and songbirds in the Arctic (see section 3.3.5). Along its banks, boaters have the opportunity to view towering cliffs, bluffs, and huge gravel bars with a rich riparian community of willows and alders, mosses and lichens. The river also provides an outstanding experience for people interested in paleontology, as evidence of mastodons, woolly mammoths and dinosaurs can be found in the riverbanks and mud cliffs (see section 3.2.7). The Utukok River has become a popular river to float for viewing caribou and their predators.

Hunting

The information in this section refers to non-subsistence hunting. For subsistence information, see section 3.4.3. The planning area falls within State Game Management Area 26A, which also includes lands outside of the area. According to statistics provided by the Alaska Department of Fish and Game, the total number of animals taken in Game Management Area 26A has increased in the last 10 years with 2007 being the highest[24]. Individual hunters get a license to hunt within the state but not within a specific unit. Hunting guides are required to obtain a special recreation permit from the BLM to guide on BLM-managed lands. There was an increase in BLM special recreation permits for guided hunting in the NPR-A over the last 5 years. In 2010 there were four permits issued compared to two permits in 2005.

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[24] http://www.wildlife.alaska.gov/index.cfm?fuseaction=harvest.lookup

Big-game animals are the primary quarry of most sport hunting in the NPR-A. Caribou of the Teshekpuk Lake Herd and the Western Arctic Herd are the most numerous big-game animal in the planning area. Subsistence hunting by North Slope residents accounts for most of the caribou harvest within the Teshekpuk Lake Herd, while sport hunters harvest primarily from the Western Arctic Herd. Most moose are taken within the Colville River drainage, particularly near Umiat. Grizzly bears are the only bears hunted in the Reserve; black bears do not inhabit the area. Grizzlies are hunted during the fall and spring, primarily in the foothills and protected river valleys of the southern portion of the planning area. For more information on species distribution, see section 3.3.7.

Fishing

The information in this section refers to non-subsistence fishing. For subsistence information, see section 3.4.3. Fishing on the Arctic Slope is largely an incidental activity conducted opportunistically by persons in the area primarily for other purposes, such as big-game hunting, float boating, construction, or government projects. There are no commercial sport fishing recreation permit requests or authorizations for the area at this time.

The number of licensed resident anglers in northern Alaska for 2007 was 33,859 or 7.1 percent of the state total (Professional Publication No. 08-01, Alaska Department of Fish and Game). Northern Alaska was classified as Arctic-Yukon-Kuskokwim. Data specific to the NPR-A is not available. In research conducted for the State of Alaska in 2007, the Arctic-Yukon Area showed that the majority of the fishing took place in the nonwinter months.

The overall, long-term potential for sport fish harvest is low when compared with opportunities in other parts of Alaska. However, because of the current lack of fishing pressure in these remote waters, good fishing can be experienced in some localities. Arctic grayling are the most widespread sport fish species in the region and are present in all major watersheds. Other sport fish species are present in the NPR-A, such as northern pike, lake trout, burbot, arctic char, Dolly Varden, and Pacific salmon species, but occur in especially low numbers. For more information on species distribution, see section 3.3.4, “Fish.”

Winter Activities

Very little winter recreation is known to occur in the planning area. Although extensive travel is usually linked to subsistence hunting and fishing and to visiting other villages, some travel is recreational. The harsh winter conditions are very hostile to any kind of winter activities. Winter activities such as snow machining, dog sledding, and possibly cross-country skiing can occur but very infrequently.

The wind in the Arctic can be a serious deterrent to any recreational activity, particularly when it blows loose snow decreasing visibility and severe wind-chill hazards. The possibility of getting lost within the vast area is another obstacle to winter recreational use by visitors and residents. The most favorable months for winter recreation are April and May, when temperatures are usually higher and periods of daylight longer.

Tourism

The State of Alaska's Report on Tourism estimates that 1.58 million out-of-state visitors traveled to Alaska between May and September 2009, with an additional 242,500 between October 2008 and April 2009 (Mc Dowell Group 2010). The last time that the state conducted a study for each region was 2006. They interviewed 240 people that visited the far north which includes the planning area, but not specific to the NPR-A. Of those, 76 percent said they were visiting for vacation/pleasure with 52 percent purchasing a multi-day trip package. Of the types of packages surveyed for use, fishing was 1 percent, adventure 35 percent, and wilderness 20 percent. The responders were not asked specifically whether they had visited the Petroleum Reserve. While the visitors may not have traveled to the planning area, the types of activities in which they had participated could be an indicator of the types of activities in which visitors to the NPR-A would also participate. With the ease of access to the Prudhoe Bay oil field public areas it is likely that tourists interested in oil and gas production would visit there rather than the NPR-A. The Arctic National Wildlife Refuge is also another possible location for tourists to visit for recreation purposes. Due to the remoteness of the planning area, at this time access for recreation purposes would more likely be through a guided experience.

Because of the lack of roads to (and within) the Reserve, recreation access is almost exclusively by aircraft, both charter and privately owned. Aircraft are available for charter at various locations; however, all charter operators are located outside of the planning area. Guide services are an additional cost and vary with the type of guided activity.

Off-Highway Vehicles

Recreational (non-subsistence) use of off-highway vehicles (OHV) is considered very low in the planning area. The area has vast stretches of wet, boggy terrain covered with tussocks, making OHV use difficult during the summer months. While some summer OHV use does occur adjacent to village lands and subsistence camps, access to the NPR-A is primarily via aircraft.

Winter use of snowmachines is more common than summer OHV use, although mostly associated with subsistence activities. Inter-village winter travel occurs along several travel routes that can migrate with changing snow and ice conditions, making a trail route difficult to establish and winter travel dangerous for the average recreational user.

3.4.6.2 Recreational Experience

For the most part, the recreational experience in the NPR-A is primitive. Virtually the entire area is characterized by an unmodified natural environment with a very low concentration of users and very little evidence of human use. The opportunity for isolation from the sights and sounds of other humans, and to feel a part of the natural environment is high. Activities are not dependent on BLM facility development. The primitive experience may be tempered, however, because use of snowmachines and motorized boats is permitted.

3.4.6.3 Existing Recreation Developments

No BLM-maintained or authorized recreational developments or structures exist in NPR-A. There is no developed road system into or through the area. Recreational access is almost entirely by aircraft. Typically, natural features such as lakes, rivers, gravel bars, and ridges serve as airstrips. Umiat, located on state land on the southeastern boundary of the planning area, has a state owned, lease holder-maintained airstrip and fuel may be available from the lease holder. Villages in the planning area have airstrips that have regular scheduled flights by small commercial planes. There are also small aircraft available for charter flights. Emergency landings are possible at various Distant Early Warning-Line sites located along the coast.

3.4.6.4 Recreation and Climate Change

As the climate gets warmer in the NPR-A (Scenarios Network for Alaska Planning 2010) the timing of recreation activities could change. Warmer and longer summers would lead to longer summer recreation use of the area. A warmer climate could increase the demand for outdoor recreation in the planning area. Climate change could have an effect on the caribou migration patterns, which would in turn change the location of guided special recreation permit activity taking place. According to the Scenarios Network for Alaska Planning fire map there would be an increase in fires in the southern portion of the NPR-A. The fires could displace special recreation permit permittees.

3.4.7 Wild and Scenic Rivers

The NPR-A IAP will provide the review of eligibility and suitability of rivers within the planning area as required by the Wild and Scenic Rivers Act and BLM planning guidance. This section describes the requirements and the review process, identifies rivers that have been reviewed for suitability in earlier plans, and lists those rivers found legally eligible as potential additions to the National Wild and Scenic Rivers System for which this plan will make suitability decisions.

3.4.7.1 Laws, Regulations, and Policies

Laws and Policies

Congress has directed the Federal Government to consider potential additions to the National Wild and Scenic Rivers System during land use planning.

Section 1(b) of the Wild and Scenic Rivers Act (16 U.S.C. §1271 et seq. [2001]) states:

> It is hereby declared to be the policy of the United States that certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations.

Section 5(d)(1) of the WSRA requires:

> In all planning for the use and development of water and related land resources, consideration shall be given by all Federal agencies involved to potential national wild, scenic and recreational river areas, and all river basin and project plan reports submitted to the Congress shall consider and discuss any such potential. The Secretary of the Interior and the Secretary of Agriculture shall make specific

> studies and investigations to determine which additional wild, scenic and recreational river areas within the United States shall be evaluated in planning reports by all Federal agencies as potential alternative uses of the water and related land resources involved.

The Departmental Manual (DM 710) assigns responsibility for implementing the Wild and Scenic Rivers Act on BLM-managed lands to the BLM.

The BLM Manual states that, "In most cases, the BLM will assess river suitability in the land use planning process, including a plan amendment if necessary (e.g., a statewide rivers evaluation, which would amend respective land use plans). This determination includes documentation of the tentative classification of the appropriate segment(s) (wild, scenic, and/or recreational)." (MS-6400 3.1).

The BLM Planning Handbook states that plans "make findings of suitability for congressional designations (such as components of the National Wild and Scenic Rivers System)" (BLM H-1601.II.B).

Within the NPR-A all decisions must be consistent with the Naval Petroleum Reserves Production Act.

Regulations

Although the Wild and Scenic Rivers Act authorizes the secretaries of Agriculture and the Interior to develop regulations to implement the Act, only Agriculture has done so.

3.4.7.2 Definitions

The federal government has been directed by Congress to identify and recommend worthy additions to the national wild and scenic rivers system during land use planning efforts, as described above. The task of making recommendations on the suitability or nonsuitability of rivers as worthy additions to the National Wild and Scenic Rivers System requires agreement on the meaning of several terms used throughout this EIS. The BLM has made every effort to remain consistent to the definitions supplied below.

Eligibility

Eligibility is mentioned once in the Wild and Scenic Rivers Act (in section 5(d)(1)), but is not defined there. Nevertheless, the term has become synonymous with an initial screening of potential rivers during a wild and scenic river study process (Diedrich and Thomas 1999, USDOI BLM 1993). In order to be eligible for designation as a component of the National Wild and Scenic Rivers System, a river must be free flowing and possess one or more outstandingly remarkable values (see below). An eligible river meets the bare minimum legal requirements for inclusion in the national system, but requires further scrutiny to determine if it is suitable as a worthy addition to the national system. Eligibility is, in legal terms, a determination made by the facts of the matter, and not a planning decision (see the definition of suitability below).

Free-flowing

Section 16(b) of the Wild and Scenic Rivers Act defines this term:

> "Free-flowing," as applied to any river or section of a river, means existing or flowing in natural condition without impoundment, diversion, straightening, rip-rapping, or other modification of the waterway. The existence, however, of low dams, diversion works, and other minor structures at the time any river is proposed for inclusion in the national wild and scenic rivers system shall not automatically bar its consideration for such inclusion: Provided, That this shall not be construed to authorize, intend, or encourage future construction of such structures within components of the national wild and scenic rivers system.

All the rivers in the planning area are free flowing.

Outstandingly Remarkable Values

An outstandingly remarkable value must be a unique, rare, or exemplary feature that is significant at a comparative regional or national scale. Such a value would be one that is a conspicuous example from among a number of similar values that are themselves uncommon or extraordinary. Only one outstandingly remarkable value is needed for eligibility. For the purposes of this report the BLM considered both a regional scale (the planning area) and the national scale. Outstandingly remarkable values may focus on human experience, such as recreation, or on features of the environment, such as spawning habitat for fish.

While the spectrum of resources that may be considered is broad, outstandingly remarkable values are directly river-related. That is, they should (1) be located in the river or on its immediate shorelands (generally within one-fourth mile on either side of the river), (2) contribute substantially to the functioning of the river ecosystem, and/or (3) owe their location or existence to the presence of the river. (The above description of outstandingly remarkable values is one commonly accepted by federal agencies.[25])

Preparing an objective assessment of outstandingly remarkable values can be difficult. In the case of the NPR-A, few people have visited the rivers in question. The planning team decided to take a permissive interpretation of the eligibility of rivers in the unplanned area. It would be difficult to argue that any particular river in the south NPR-A did not possess outstandingly remarkable values, given the unique and remote setting when evaluated in a national context, and the near necessity for recreationists to use rivers to move through the area in summer. While most of the rivers in the area are difficult to float during most of the summer, they provide much easier travel routes than hiking overland. The planning team relied on public input during scoping and on interviews with agency staff who have been to these rivers to identify the rivers listed as eligible below. For recreational users who commented at the scoping meetings all the rivers in Table 3-32 on page 448 provided outstandingly remarkable opportunities for recreation.

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[25] http://www.nps.gov/ncrc/programs/rtca/nri/eligb.html

Suitability

One of the outcomes of the NPR-A IAP will be decisions on the suitability or nonsuitability of the rivers within the planning as worthy additions to the national wild and scenic rivers system. In contrast to eligibility, which is based on a factual description of the existing situation, suitability is a decision based on weighing various elements through the planning process. Details on the process used to make suitability decisions are given below. Rivers that are found suitable through the planning process should be recommended for designation by Congress. During consideration by Congress, rivers determined to be suitable would be managed to protect free-flow, water quality, and identified outstandingly remarkable values. We will examine the potential effects of congressional designation of several rivers as we assess the impacts of the range of alternatives in this document.

The decision on suitability will be made after answering the following questions:

- Should the river's free-flowing character, water quality, and outstandingly remarkable values be protected, or are one or more other uses important enough to warrant doing otherwise?
- Would the river's free-flowing character, water quality, and outstandingly remarkable values be protected through designation?
- Would designation be the best method for protecting the river corridor? The benefits and impacts of wild and scenic river designation must be evaluated, and alternative protection methods considered.
- Is there a demonstrated commitment to protect the river by any non-federal entities, which may be partially responsible for implementing protective management?

3.4.7.3 Suitability Determinations

The Wild and Scenic Rivers Act lists several factors that must be addressed in reports on suitability or nonsuitability:

- Current status of land ownership and use in the area.
- Reasonably foreseeable potential uses of the land and water which would be enhanced, foreclosed, or curtailed if the area were included in the national wild and scenic rivers system.
- Federal, state, local, tribal, public, or others' interests in designation or nondesignation.
- The federal agency that would administer the river, if it were designated.
- The extent to which the costs of river management would be shared by state and local agencies, if it were to be designated.
- The ability of the BLM to manage and/or protect the river as a wild and scenic river area.
- Historical or existing rights, which could be adversely affected by designation.
- The estimated cost to the United States, if the river were to be designated.

These factors will be addressed in the record of decision.

Previous Suitability Decisions by Department of the Interior

The Naval Petroleum Reserves Production Act section 105(c) study made suitability recommendations for potential wild and scenic rivers in NPR-A. The Utukok, Nigu-Etivluk and Colville rivers were found to be eligible, but only the Colville above Umiat was recommended to DOI as suitable. (DOI, 1979b). The IAP for Northwest NPR-A identified 22 rivers as eligible. The record of decision for that IAP included the finding that no rivers in the Northwest NPR-A were suitable as worthy additions to the national wild and scenic rivers system. The most recent update to the IAP for Northeast NPR-A reviewed the eligibility of 18 free-flowing streams and identified 1 eligible river: the Colville (which was also identified in the Northwest NPR-A IAP). The Colville was determined to be not suitable as a worthy addition to the National Wild and Scenic Rivers System in the areas where management of the river environs were shared by the State of Alaska, Arctic Slope Regional Corporation, and BLM. The BLM has reviewed and considered all of the relevant information available since these earlier analyses and has found no changes in factors relevant to wild and scenic river designation (MS-6400 2.1). No new information was submitted during scoping relevant to previous conclusions regarding potential additions to the national wild and scenic rivers system considered in previous IAP environmental impact statements and records of decisions. However, the rivers that the BLM has not evaluated for suitability in an Environmental Impact Statement will be considered in this plan.

Eligible Rivers for Which This IAP Process Will Make Suitability Decisions

All the rivers in the planning area are free flowing, so identifying eligible rivers according to the Wild and Scenic Rivers Act rests on the existence of outstandingly remarkable values. Previous planning and inventory efforts were reviewed. The planning team did not find any significant changes to suitability criteria for rivers found not suitable in the most recent planning efforts for the northern portion of the planning area, and this IAP will not revisit the nonsuitability findings for the 22 eligible rivers described in the preceding section. Throughout the scoping process, in public meetings, planning team sessions, and through written scoping comments, the planning team considered eligibility of the rivers that had not been recently re-evaluated, and identified 12 eligible rivers as shown in Table 3-32 The rivers requiring suitability determinations through this IAP are shown on Map 3.4.7-1.

3.4.7.4 Climate Change and Wild and Scenic Rivers

The trends and predictions regarding climate are described in Appendix C. Changes to climatic conditions could affect water availability in streams (for example, by changing the amount and timing of discharge) and could affect outstandingly remarkable values such as caribou habitat (for example, by changing the composition and availability of forage). Climate trends for such resources are described elsewhere in Chapter 3.

Table 3-32. Rivers eligible for Wild and Scenic River status

Stream name	Extents	Outstandingly remarkable values
Nigu	From NPR-A boundary to confluence with Etivluk River	recreational, wildlife, scenic and cultural
Etivluk	From confluence with Nigu to Colville	recreational, wildlife, scenic and cultural
Ipnavik	Headwaters to Colville	wildlife, scenic
Kuna	Headwaters to Colville	wildlife, scenic
Kiligwa	Headwaters to Colville	wildlife, scenic, cultural, geologic, subsistence
Nuka	Headwaters to Colville	wildlife, scenic
Driftwood Creek	Headwaters to Utukok	wildlife, scenic, cultural, geologic, subsistence
Utukok	Headwaters at confluence of Tupik and Kogruk creeks to NPR-A boundary approximately 198 miles	recreational, wildlife, scenic, subsistence, and cultural
Awuna	Headwaters to Colville	wildlife, scenic, cultural, geologic, subsistence, recreational
Carbon Creek	Headwaters to Utukok	recreational, wildlife, scenic, cultural and subsistence
Upper Colville	From headwaters (Storm Creek) downstream in all portions in which the river and both banks are in the NPR-A	wildlife, scenic, cultural, geologic, subsistence
Kokolik	Southern NPR-A boundary to northern boundary	recreational, wildlife, geologic, cultural and subsistence

3.4.8 Wilderness Characteristics

Wilderness means different things to different people. As explained in Roderick Nash's book, "Wilderness and The American Mind,"

> ...there is no specific material object that is wilderness. The term designates a quality (as the "-ness" suggests) that produces a certain mood or feeling in a given individual and, as a consequence, may be assigned by that person to a specific place. Because of this subjectivity a universally acceptable definition of wilderness is elusive. One man's wilderness may be another's roadside picnic ground.

3.4.8.1 Applicable Laws

Naval Petroleum Reserves Production Act of April 5, 1976, Public Law 94-258

Section 105(c) of the Naval Petroleum Reserves Production Act directed that the Secretary of the Interior establish a task force to conduct a study for determination of the values, and best uses for, the lands contained within the NPR-A. In 1977–78 a field study was completed throughout the NPR-A in compliance with section 105(c). The study included looking at the characteristics of wilderness values based on criteria from the Wilderness Act.

Federal Land Policy and Management Act of October 21, 1976, Public Law 94-579

Section 201 of FLPMA states that the Secretary shall prepare and maintain on a continuing basis an inventory of all public land including but not limited to their resources and values. Section 603 directed the Secretary to look at the wilderness characteristics of lands identified in section 201 and recommend to Congress lands for preservation as wilderness. The Naval Petroleum Reserves Production Act, however, exempted the NPR-A from section 603.

Alaska National Interest Lands Conservation Act of December 2, 1980, Public law 96-487

In section 1001(a) of the ANILCA, Congress directed the Secretary of the Interior to conduct studies, review the wilderness characteristics and make recommendations for wilderness designation of federal lands in Alaska and specifically named the NPR-A as being excluded. Furthermore, in section 101(d) Congress stated their belief that the Act provided sufficient protection of public lands in Alaska and no further legislation designating new conservation system units would be needed. Section 1326(b) states “No further studies of Federal lands in the State of Alaska for the single purpose of considering the establishment of a conservation system unit, national recreation area, national conservation area, or for related or similar purposes shall be conducted unless authorized by this Act or further Act of Congress.” See section 1.5.1 for more information.

Energy and Minerals Act of December 12, 1980, Public Law 96-514

This act amended the Naval Petroleum Reserves Production Act and exempted the NPR-A from the provisions of section 603 of Federal Land Policy and Management Act.

3.4.8.2 Previous Environmental Documents

The final environmental impact statement on oil and gas leasing in the NPR-A of February 1983 stated: “The BLM recognizes the Congressional intent of PL 96-514 which indicates that no “wilderness” designations will be made in the Reserve and the intent of PL 96-487. The BLM cannot reinterpret Congressional authority through administrative procedures.”

The Northeast NPR-A IAP/EIS dated August 1998 stated “Because wilderness designation would not meet the purposes and objectives of this planning effort, BLM decided not to consider possible wilderness designation for the planning area in the IAP/EIS.”

In its November 2003 Northwest NPR-A IAP/EIS, the BLM separated the Northwest NPR-A planning area into seven different land areas for wilderness consideration using hydrologic borders. For the plan, the BLM conducted an inventory of three of the seven looking at wilderness characteristics. One alternative identified areas for possible designation by Congress as Wilderness; this alternative, however, was not the preferred alternative and the BLM made no recommendations for wilderness designation.

The Northeast NPR-A Final Supplemental Integrated Activity Plan/Environmental Impact Statement dated May 2008 did not consider wilderness designation within the planning areas in any alternative. “Because creating new wilderness designations is inconsistent with this management objective, alternatives proposing such an action are outside the scope of the Amended IAP/EIS and this Supplement thereto.”

3.4.8.3 Wilderness Inventory of the NPR-A

While the 105(c) study was conducted over 30 years ago, there has been very little change to the wilderness characteristics of the area relative to the size of the planning area. (There has been some oil and gas exploration in the northern parts of the NPR-A, leaving little mark on the land.) Consequently, the BLM is adopting the analysis of the 105(c) studies as a basis for analysis of wilderness characteristics in this plan. This approach was also supported by commenters during scoping.

The 105(c) studies broke down the NPR-A into eight hydrologically based areas for wilderness consideration. With the exception of the Kasegaluk Lagoon, the BLM revisited the eight areas during the summer 2010 field season. (The Kasegaluk Lagoon was not visited due to poor weather conditions during scheduled helicopter time.) The Kasegaluk Lagoon area had, however, been visited in 2002 as part of an inventory associated with the Northwest NPR-A planning effort. Just like the 105(c) studies, parts of the areas were visited, not the entire NPR-A. The BLM included site inventory evaluations for the 2010 visits.

3.4.8.4 Wilderness Characteristics

There are no Congressionally-designated wilderness areas in the NPR-A; however, almost all BLM-managed lands within the planning area, especially those lands that are more than five miles from villages, offer the wilderness characteristics of solitude, opportunities for primitive and unconfined recreation, and for the most part are natural.

The planning area was evaluated for wilderness characteristics during the section 105(c) studies in 1978. NPR-A is one of the largest remaining wilderness resource areas in the country. Practically all of NPR-A remains in a similar state as it was during that study. The reserve lacks significant physical intrusions due to the extreme remoteness of the area and the lack of development in most of the area since its establishment as a petroleum reserve in 1923.

Residents of the area do occupy seasonal dwellings or fish camps, which if not entirely compatible with naturalness and solitude, are nonetheless minor impacts to an otherwise primitive area. While the local population travels extensively by motorized vehicle (primarily snowmachines and OHVs) over parts of the planning area, particularly near communities, there are no roads outside the communities. In spite of the NPR-A having been subjected intermittently to oil and gas exploration since the 1920s, the overall character of the planning area (excluding private lands) is that of a natural, undisturbed area, with very few obvious signs of modern human influence or presence. A visitor to the area or an inhabitant of one of the few settlements in or near the NPR-A can easily find opportunities for solitude (USDOI BLM 1978d).

Four characteristics of wilderness are:

- Naturalness-"generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable"
- Solitude or Primitive Unconfined Recreation-"has outstanding opportunities for solitude or a primitive and unconfined type of recreation"

- Size-"has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition"
- Features of Scientific, Educational, Scenic, or Historical Value-"may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value"

Below is a description of these characteristics in the planning area.

Naturalness

Most of the vast NPR-A appears to have had very limited human intrusion. A portion of the planning area, however, is used and has been used for many years by the people who live in villages in and near the Reserve. Use consists of subsistence hunting with OHVs and snowmachines. Scars of past activity are still noticeable in some parts of the planning area today as they were in the timeframe of the 105(c) studies. Two-wheel track trails have been established from village to village and from villages to camps along river corridors by locals for subsistence use. Many trails have no specific direction and were made in pursuit of subsistence resources. The trails are a result of use, and are not groomed or maintained. Cabins, generally used as seasonal dwellings for subsistence fishing camps, are scattered along the rivers and some lakes. Native Allotments either are or will become private land and are of greatest utility to residents as subsistence camps. See section 3.4.3 for more information on subsistence.

Guided scenic, wildlife viewing, and hunting trips; recreation trips; and research work have been localized, temporary, and with only seasonal impacts. More important are impacts from facilities (gravel pads for camps, airstrips, wellheads, etc.) that remain from past oil and gas exploration, many predating the 105(c) studies. Most of these facilities are in various stages of reclamation. Some of the old methods of oil and gas exploration and the transportation of personnel and equipment did leave lasting impacts on the soils and vegetation of the area.

Solitude or Primitive Unconfined Recreation

Outstanding opportunities for solitude and a primitive and unconfined recreation experience do exist in the NPR-A. These opportunities are largely attributed to the extreme remoteness of the area. Even in Alaska, there are a limited number of locations where an individual can be more than 100 miles in any direction from the nearest population center. This isolation provides exceptional opportunities for wilderness experiences.

To many people, wilderness evokes images of an area where one can experience solitude or serenity and that requires self-reliance. Recreational users of wilderness also expect outstanding opportunities for unusual adventure, excitement, and challenge. Nearly all of the lands within the NPR-A offer a wilderness environment in which visitors can experience feelings of solitude, adventure, and serenity.

The BLM received letters from the public during scoping that demonstrate the area's wilderness attributes. The following is an excerpt from one of the comments received:

> After following the Chukchi Coast north for two hundred miles we turned inland at the muddy delta of the Utukok River and began lining our kayaks upstream into icy winds or clouds of mosquitoes. One studies a lot of gravel bars while lining

> a boat upriver; fossils laid down on ancient sea floors, Pleistocene horses teeth, wooly mammoth ivory and Eskimo artifacts hidden among the stones kept our minds occupied with varied pasts this place has seen. One hundred and sixty miles later, we ran out of water in a small, unnamed tributary that flows north from Lookout Ridge and began hauling multiple loads on our backs, pulling our kayaks along the tundra behind until we crossed the divide and dropped into the Colville drainage. I've seen more spectacular places in Alaska, but never a wilder or equally remote place. If you've never been out in truly wild country, weeks of travel beyond the nearest other people, it's an experience I'd recommend highly, and one which today can be found in pitifully few parts of the world.
>
> Paddling down the Colville River from near its headwaters to the Beaufort Sea was as relaxing as lining up the Utukok was strenuous. Gazing out from bluff after bluff we could survey hundreds of square miles of wetlands and rolling tundra. Wolves, grizzlies, foxes and, occasionally, muskoxen were our companions as we coasted hundreds of miles down this lovely arctic river. One afternoon, as we ate our lunch facing the river, over a thousand caribou quietly filled the valley behind us, washed around us like flowing streams, and finally moved off into the distance! Scores of loons, ducks, geese, and swans graced the waters of river, lake and pond, while the keening cries of peregrines, Gyrfalcons and Rough-legged Hawks wheeling above their nesting cliffs became commonplace...an experience most naturalists would give their eye-teeth to share! We saw neither people nor their machines between Point Lay and Umiat, for over forty days. That's remarkable, even in Alaska! (Miller 2010)

The bleakness of the far north environment contributes to the impression of solitude. Even at a short distance from the few settlements, a visitor is challenged with the necessity of "fending for one's self." Challenge comes from chance encounters with grizzly bears, coping with the potentially harsh and rapidly changing weather, and particularly in the winter, depending upon one's own skills for traveling and subsisting in the wilderness environment (USDOI BLM 1978d).

Size

The planning area meets the characteristic of size that is at least 5,000 acres.

Features of Scientific, Educational, Scenic, or Historical Value

The NPR-A contains several wilderness supplemental values. Among these is the varied wildlife in the area and the associated opportunities for scientific study.

Wildlife

Wildlife is an important characteristic that affects the quality of the wilderness experience. Wildlife enhances the wilderness experience by its very presence, particularly those species that commonly cause people to visualize wild country. Wilderness-associated species are those often associated in the public's mind with (although not always biologically dependent on) a wilderness-like environment. In the Arctic, these species may include grizzly bear, polar bear, wolf, wolverine, caribou, moose, Dall sheep, muskox, fox, loons, gyrfalcon, peregrine falcon, golden eagle, and ptarmigan. Wildlife-viewing opportunities are very good because some forms of wildlife are locally abundant, but more concentrated along river drainages and easily viewed at comfortable distances across relatively flat terrain. Because of their intolerance of humans or their need for large areas of untrammeled land, some species may survive best in wilderness settings, allowing visitors an opportunity for viewing that they might otherwise never have. Commercial guides permitted by the BLM most commonly reported providing their clients with caribou viewing in 2009 and 2010, the most recent years for which reporting has been completed.

Opportunities for Scientific Study

Opportunities for nature study or informal outdoor education and formal scientific study are important attributes of wilderness if they can be carried out in a manner compatible with wilderness. Wilderness areas present an ideal place for observation of plant and animal relationships that have developed largely devoid of human manipulation. Wilderness also provides opportunities for comparing natural environments with unprotected areas undergoing more intensive modification.

In the past few summers there has been an increase in research that has been conducted in the NPR-A both by federal entities and universities. Climate change, avian, polar bear, geology, vegetation, hydrologic, fire, and paleontological studies have taken place.

The NPR-A has unique value for scientific study for a number of reasons. One is that the NPR-A represents a broad transect containing many typical features of the environmental gradient between the Arctic coast and the Brooks Range. The coastal marine environment grades into the wet sedge meadows, to the upland tussock tundra, to the alpine tundra with several less distinct graduations between each of these divisions. For information on vegetation, see section 3.3.1, for physiographic information see Map 3.2.4-1.

3.4.8.5 Summary of Wilderness Characteristics and Attributes in NPR-A by Area

Based on the 105(c) study and the 2002 and the 2010 wilderness inventory reviews, the BLM's Arctic Field Office evaluated the wilderness characteristics and attributes in the NPR-A using the BLM Instruction Memorandum No. 2011-154 dated July 25, 2011. As noted previously, the 105(c) studies divided the NPR-A into eight areas for evaluation of wilderness characteristics (Map 3.4.8-1). Although most of the NPR-A possesses wilderness characteristics, there are distinct differences in the characteristics, attributes, and uses within the Reserve. Of the eight areas evaluated in the 105(c) study, two were found to have less to offer than the other six and therefore were not assigned a name during the 105(c) study. They are shown on Map 3.4.8-1 as NPR-A G and NPR-A H. The 105(c) study found that the DeLong Mountains/Arctic Foothills, Utukok River Uplands, Teshekpuk Lake area, Colville River Valley, Kasegaluk Lagoon, and Ikpikpuk River had more outstanding wilderness characteristics. Selections of these areas were based upon consideration of the wilderness attributes and ecological reserves, which are values similar to those used to evaluate wilderness.

Wilderness Evaluation Area NPR-A G

The villages of Barrow, Wainwright, and Atqasuk are within the boundaries of the NPR-A G area. Together their population in 2010 was 5,001. The only roads in the area are those found within the villages. The lands within a 5-mile radius around each village do not meet the criteria of naturalness; however, the rest of the lands do meet the criteria and are described below. The area has many legacy wells (see section 3.2.11) and many federal oil and gas leases. This does not detract from the overall character of naturalness due to the vast amount of land and difficulty accessing the sites.

Most of the permitted activity in this area is for research, oil and gas related activities, or activities associated with the winter transport of items to the villages with lightweight vehicles that travel on the snow. There is opportunity for unconfined recreation. Special recreation permits issued by the BLM in the area are generally for guided hunts.

Wilderness Evaluation Area NPR-A H

The village of Nuquisit with a 2010 population of 402 is located within the NPR-A H area. Umiat is also located in NPR-A H. The only roads in the area are those found within the village of Nuquisit and at Umiat. The lands within a 5-mile radius around each do not meet the criteria of naturalness; however, the rest of the lands in this area do meet the criteria and are described below. The area has many legacy wells (see section 3.2.11) and many federal oil and gas leases. This does not detract from the overall character of naturalness due to the vast amount of land and difficulty accessing the sites.

This area has the opportunity for unconfined recreation. Umiat has an airstrip that allows people easier access to the area than found in other areas of the NPR-A.

DeLong Mountains/Arctic Foothills

The DeLong Mountains/Arctic Foothills area is a corridor along the entire southern boundary of NPR-A that encompasses the north face of the DeLong Mountains and a large part of the southern foothills within NPR-A. This area includes 8 percent of the NPR-A. The area provides many primitive recreation opportunities and the 105(c) study found that it has the greatest scenic variety of any part of the NPR-A. The DeLong Mountains/Arctic Foothills area provides summertime opportunities for backpacking, exploring, nature photography, wildlife viewing, camping, and limited fishing and hunting.

The area provides habitat for caribou, wolf, and grizzly bear, which prefer large areas of minimally disturbed land. The mountain passes between the North Slope and the Noatak River drainage are frequently used by some of the Western Arctic Caribou Herd migrating between winter and summer ranges. The passes are also used by other animals whose habitat includes both sides of the mountain range and by some of the birds annually migrating to and from the North Slope.

During scoping for the plan, the BLM received comments requesting that the DeLong Mountains be designated as wilderness. The following is an excerpt from one of the comments received:

> The DeLong Mountains and nearby arctic foothills constitute wild rolling grasslands bounded by rugged mountains, and hark an American back to the early glimpses of where the grasslands met the Rockies before the interstates came through and the coal veins were strip-mined. Here is a precious experience for Americans at the farthest end of the continent, re-creating something from out of our past, yet still in existence today. In these foothills and the adjacent Utukok Uplands I have watched thousands of caribou in migration, and a dozen or more

> grizzlies attending them. I have seen wolf sign there and quite a bit of archeological signatures from stone-age tool-making by earlier humans. There's a reason a nearby creek is named Chert Chip Creek. (Fair 2010)

A letter from The National Parks Conservation Association stated:

> Our interest in your planning effort is the adjacent lands to the north of two of America's wildest national park units: Noatak National Preserve and Gates of the Arctic National Park & Preserve and the impact your planning decisions could have on Noatak and Gates' outstanding wilderness values. The northern edge of these two park units at the DeLong Mountains and Arctic Foothills define the southern edge of the NPR-A. The geopolitical boundary that defines the NPR-A and the national park units to the south, do not delimit physical, biological, or ecological influences and interactions. This area has exceptional scenic, wilderness, and wild river values, which provide truly exceptional opportunities for wildlife viewing, hiking, boating, hunting, fishing, and photography in truly wild and remote country. Opportunities like this are rare in North America (Stratton 2010).

Utukok River Uplands

The size of the Utukok River Uplands area is approximately 22 percent of the acreage of the NPR-A and includes the primary calving grounds of the Western Arctic Caribou Herd and almost all of the Utukok River within NPR-A. Particularly important to survival of caribou is an untrammeled area such as the Utukok River uplands where snow cover is minimal in the early spring. Other wildlife in the area that depend upon large ranges or are generally intolerant of man are grizzly bear and wolf. There are also fox and squirrels that populate the area. The recreation value of the Utukok River includes the excellent opportunities to view wildlife, to float a river, and to hike within a natural arctic environment. The area provides opportunities for study of large natural floral/fauna communities. Floating the Utukok River also avails one the opportunity to see and hear many species of birds.

The Utukok River was floated by BLM employees in June of 2011. At no time during the float was another human being encountered. It was a very peaceful solitary experience. Many animals and birds were seen and pictures taken. There were guided special recreation permit trips that also took place in June, but dates were arranged so that all would have the opportunity to experience the solitude and primitive experience the area offers.

There is a legacy well (see section 3.2.11) that was drilled by the Navy in 1951 within the northern portion of the unit. The wellhead remains as does a small cabin next to it. This apparatus does not diminish the naturalness of the area. Due to the size and remoteness of the unit, one would have to have the latitude and longitude of the site to locate it.

The Utukok River area was specifically mentioned in the Naval Petroleum Reserves Production Act as a place of significant subsistence, recreational, fish and wildlife, historical and scenic value that should be provided maximum protection of such surface values to the extent consistent with the Act. Therefore, in 1977 the Secretary of the Interior designated the Utukok River Uplands Special Area.

Teshekpuk Lake

The Teshekpuk Lake area comprises 7 percent of the total NPR-A acreage. Teshekpuk Lake and the land generally north and south of the lake are part of a larger area known to be an important concentration area for several species of waterbirds (section 3.3.5). There are many large uniformly oriented lakes with a water sedge tundra ecosystem not present in the rest of the NPR-A. The area is also important to caribou (section 3.3.6). The caribou and bird activities in the area make it very attractive to researchers wishing to study their activity. Besides permitted research for these studies, there are also permitted research projects for climate change in the area. The area also contains unique biological and geomorphical features. The area offers outstanding opportunities for scientific study and education.

There are a few legacy wells (see section 3.2.11) and a few current federal oil and gas leases within the area. Seven wells have been drilled in the area since 1988. These wells occupy a small fraction of the lands within the Teshekpuk Lake area and do not detract from the wilderness characteristics of the area.

The Teshekpuk Lake area has opportunity for solitude. There are no villages or roads within the area.

The Teshekpuk Lake area was specifically mentioned in the Naval Petroleum Reserves Production Act as a place of significant subsistence, recreational, fish and wildlife, historical and scenic value that should be provided maximum protection of such surface values to the extent consistent with the act. In consequence, in 1977 the Secretary of the Interior designated the Teshekpuk Lake Special Area.

Colville River Valley

The Colville River Valley Area comprises 12 percent of the total NPR-A acreage. The area remains in a natural condition with the majority of use being subsistence and recreation. There were two wells drilled over 30 years ago on Knifeblade Ridge and the Awuna oil well was drilled in this region prior to the 105(c) study (see section 3.2.11), which in comparison with the size of the area was a minor occurrence and is substantially unnoticeable. There are no villages, roads, or settlements within the unit, thus allowing for outstanding opportunity for solitude. Primitive recreation opportunities along the river are excellent. The Colville River Valley from the Nuka River to Ocean Point up river from the village of Nuiqsut has prime nesting habitat for several species of cliff dwelling raptors (section 3.3.5). It also contains most of the moose winter habitat in the NPR-A (section 3.3.6). The eastern portion of the area is part of the annual range of the Teshekpuk Lake Caribou Herd. The Western Arctic Caribou Herd also uses the area as part of its summer range.

There are oil and gas leases in the Umiat area. Recognizing its value for habitat for arctic peregrine falcon the Secretary of the Interior designated much of the Colville River in the NPR-A as the Colville River Special Area in 1977.

Kasegaluk Lagoon

The Kasegaluk Lagoon area encompasses 2 percent of the acreage of the NPR-A. This area is roadless and natural, with some impacts from human presence along the lagoon shoreline; it offers outstanding opportunities for primitive recreation endeavors. The coastal area of the Chukchi Sea between Wainwright Inlet and Icy Cape includes offshore islands, lagoons, small estuaries, and numerous lakes and ponds. The area contains one of the Arctic's best examples of a barrier island/lagoon environment. Kasegaluk Lagoon provides unusual primitive recreation opportunities, including recreational boating and sightseeing. In the spring and fall, marine mammals may be seen migrating fairly close to shore. In the late summer, large numbers of shorebirds and waterfowl, including eiders and black brant, may be seen in the area. The area offers outstanding opportunities for scientific study and education. Recognizing its wildlife and recreation value, the Secretary of the Interior designated it a Special Area in 2004.

Ikpikpuk River

The Ikpikpuk River area comprises about 16 percent of the NPR-A. The corridor encompasses the entire Ikpikpuk River, Kigalik River, and Maybe Creek, the shoreline around Smith Bay, and the land between Smith Bay and Dease Inlet. The area generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable. The area had several oil and gas wells drilled over 30 years ago (section 3.2.11). There are several federal oil and gas leases that have been sold in the area and exploration wells have been drilled since the 1999 oil and gas lease sale. However, this activity compared to the massive size of the area has comprised a small amount of land and would not prevent the area from being considered wilderness. The area has outstanding opportunities for solitude or a primitive and unconfined type of recreation. The area has many miles of river that recreationists could make use of without ever encountering another human being.

This area contains topographic and ecologic features typical of the northern slope of the Arctic foothills and the coastal plain as well as paleontological features. Topographic and permafrost features include high and low center polygons, pingos, oriented lakes, oxbow lakes, meander scrolls, beaded streams, and dune areas. Ecologic features include examples of several stages of lake basin development, waterfowl nesting habitat, wet sedge tundra plant communities, riparian willow grove, and many lichen types. Several sites within the corridor have significant paleontological and archaeological value.

3.4.8.6 Wilderness Characteristics and Climate Change

The wilderness characteristics of size and outstanding opportunities for solitude and primitive and unconfined recreation would not be affected by climate change. However, the quality of supplemental values that an area may also contain of ecological, geological, or other features of scientific, education, scenic, or historical value may be affected if the climate continues to warm in the NPR-A (Scenarios Network for Alaska Planning 2010). See climate sections within the "Physical Environment" and "Biological Resources" sections (sections 3.2 and 3.3) for more information.

3.4.9 Visual Resources

Visual resource management is the BLM approach for identifying scenic quality and setting minimum quality standards for management of the aesthetic values by classifying all lands into one of four inventory classes. The visual resource inventory class assigned to a land area depends upon three factors: scenic quality, visual resource sensitivity, and visual distance zones. An in-depth inventory of visual resources within the planning area was conducted as part of the NPR-A 105(c) studies completed in 1979. The inventory classes do not establish management direction. They are informational in nature and provide the basis for considering visual values during land management planning.

3.4.9.1 Scenic Quality

The scenic quality evaluation process in 1979 consisted of subdividing the NPR-A into homogeneous areas called scenic quality rating units (SQRU). As directed by BLM policy the primary visible elements of landform, vegetation, water, color, scarcity, and cultural modifications that make up a landscape, were used as rating criteria. The rating criteria for scenic quality were applied to each scenic quality rating unit which were, in turn, compared to all of the scenic quality rating units in the NPR-A. The rating applied to the unit as a whole, not just one area or how it was seen from one location. Each scenic quality rating unit was rated-on a scale of A through C for the quality of its visual aesthetics (Map 3.4.9.1-1):

- Class A SQRU has a great deal of visual variety, contrast, and harmony.
- Class B SQRU has a moderate amount of visual variety, contrast, and harmony.
- Class C SQRU has little visual variety, contrast, and harmony

The classification was based on the premise that all landscapes have some scenic value, but those with the most visual variety, contrast and harmony have the highest scenic value.

The NPR-A was divided into seven scenic categories: the coast, the wet plains, the plains, the ridges, the Colville River Valley, the foothills, and the mountains. The categories were found to have a number of subunits (Table 3-33). Below is more specific information about the scenic categories as found in the 105(c) study. With the exception of SQ05, the SQRU ratings remain as determined in the 105(c) study. Arctic Field Office staff reevaluated this unit for this planning effort and upgraded the visual rating for Teshekpuk Lake, Dease Inlet/Admiralty Bay, and the Kuk River and their shorelines to Class A.

Coastline

Coastlines include four subunits of characterization for coastline with landform being the primary element that distinguishes the subunits from one another. There is little physical relief along the Arctic coast therefore topographic changes are visually significant where they occur. Wind and tidal action have shaped the offshore islands and spits. The Chukchi Sea Coast has a low steep bluff, which is higher along Skull Cliff between Peard Bay and Barrow and is visually significant. From Point Barrow east, the land is just 3 to 6 feet higher than the sea. The only distinguishing landforms in this stretch are the offshore islands and the spits between Point Barrow and Tangent Point. The remainder of the coast to the mouth of the Colville River lacks islands or spits. The sea is a dominant element in the coastal landscape.

Distinctiveness

The coast scenery unit may be categorized as rare and memorable within the region, since it is the only unit that borders the sea and has characteristics of seasonal moods created by the sea ice. Sea mammals and other wildlife add significant visual interest to the total area, but the shore ice and pressure ridges are most evident and spectacular in the Chukchi Coast.

Table 3-33. Scenic quality rating units (SQRUs) and subunits

Basic category	Reference number	Subunit	Scenic quality rating
Coastline	SQ01	Chukchi Coast	B
	SQ02	Elson Lagoon and Dease Inlet	B
	SQ03	Beaufort Sea Coast	C
	SQ04	Barrow	C
Wet Plains	SQ05	Large waterbodies (Kuk River, Wainwright Inlet, Admiralty Bay and Teshekpuk Lake)	A*
	SQ06	Oriented Lakes (south of Barrow)	B
	SQ07	Remaining Wet Plains	C
Plains	SQ08	Dry Plains	C
Ridges	SQ09	Western Portion (west of Utukok River and Carbon Creek)	B
	SQ10	Eastern Portion (remainder of ridges landscape)	C
Colville River Valley	SQ11	Upper Colville (headwaters to Etivluk River)	B
	SQ12	Middle Colville (Etivluk River to Chandler River)	A
	SQ13	Lower Colville (Chandler River to Ocean Point)	B
Foothills	SQ14	Foothills	B
	SQ15	Liberator Ridge (Jubilee Creek to Kuna River)	A
Mountains	SQ16	DeLong Mountains	A

*This is an adjusted SQRU from the 105(c) study. (Information from 105(c) study)

Wet Plains

This scenic unit is composed of that part of the flat plains area near the coast, which includes many thousands of small lakes, as well as a few larger lakes, bays, and inlets. The distinguishing features of the plains are its vastness and flatness, top-dressed by the thousands of lakes and ponds. The wet plains have three subunits as shown in Table 3-33. The type of waterbodies within each subunit determined which SQRU the subunit was placed in. Water is the dominant visual element of the unit whether it is viewed from the ground or air. The wet plains contain three large bodies of water (Kuk River-Wainwright Inlet, Admiralty Bay and Teshekpuk Lake) and polygonal ground patterns caused by frost action. The other subunits are dominated by lakes with one subunit having more visual dominance than the other.

Distinctiveness

The oriented lakes and polygonal patterns are outstanding and memorable elements of this unit. Teshekpuk Lake is one of the largest lakes in the state and, therefore, rates high in distinction. Wildlife viewing in the unit is generally memorable since caribou, waterfowl, and other species are present during much of the year. Such a combination of features is available in the United States only in the Arctic and western Alaska.

Plains

The plains region is large and visually expansive. This unit was not subdivided because of the generally homogeneous nature of the unit. The Plains SQRU is a flat, continuous plain with little visible topographic relief except for widely scattered drainage areas, pingos, and polygons. Its vegetation consists of low-growing tussock tundra species. Compared to the Wet Plains, there are fewer and smaller waterbodies in this unit. Color contrast is subtle within the more homogeneous vegetation. Because the Plains are almost flat, there is little contrast between the blues of the water and the greens of the vegetation, unless you are in the immediate vicinity of the water.

Distinctiveness

This unit is neither particularly distinctive nor memorable.

Ridges

This scenic unit displays a marked variation in topographic relief and has a wide variety of plant species. The waterbodies and river corridors are commonly confined and add diversity by dissecting the landform into small segments. The relief in the unit varies from flat valley bottoms to dissected rolling hills and steep cliffs. The area is cut by meandering streams and by ridges which are gently sloping on one side and steep on the other. In this unit streams and small rivers are dominant elements in the landscape. The water generally moves slowly; there are many meanders but few cascades or other signs of water movement.

Distinctiveness

Despite the topographic variety, the unit generally lacks any element that would make its visual quality distinctive or memorable. The Valley of the Willows, which is located on the Ikpikpuk River and falls within the far western border of the Teshekpuk Lake Special Area, is reported to have interesting and unique paleontological and ecological features but is not visually distinctive.

Colville River Valley

The Colville River is the largest river on Alaska's Arctic Slope. Its course extends more than 400 miles and cuts across several other scenic quality rating units. The landform varies considerably along the length of the river as it flows through talus slopes, rock bluffs, and flat, open meander channels. The twisted river channels and irregular oxbow lakes add pattern and line to the landscape. The bluffs along the river in SQ12 and SQ13 (Map 3.4.9-1) create some of the finest scenery within the NPR-A. Compared with other scenic quality rating units, this unit exhibits greater visual difference in vegetation, and has more variety in form, texture, and color. Color is more varied within much of the Colville Valley than in other parts of the Reserve.

Distinctiveness

By length alone, the Colville River is unusual in the Arctic. The volume of water carried and the size of the valley also make the Colville River unique within the NPR-A. The massive river bluffs are unlike any others within the study area; few cliff areas in the NPR-A are as spectacular as those found in Killik Bend.

Foothills

The foothills serve physically and visually as a transition between the broad plains and ridges to the north and the more rugged and massive mountains to the south. Although the landscape appears quite diverse, it consists primarily of gentle to steep, rolling hills and massive rock outcrops in the form of sawtooth ridges. The unit is heavily dissected by streams and rivers.

Distinctiveness

The area around Liberator Ridge (SQ15) is an excellent example of the scenic quality, which is created when the elements of landform, soil, rock, vegetation, and water contrast moderately in form, line, color, and texture. The rock “spires” are very unusual within the NPR-A.

Mountains

The mountain unit forms a rather narrow scenic unit along the southern boundary of the NPR-A. The masses of rock craggy peaks, broad talus slopes, green valleys, and small creeks combine to form some of the finest scenery in the Reserve. Although quite impressive, these mountains are not as high, rugged, or spectacular in other respects as those of the central and eastern Brooks Range. This unit includes only the northern fringe of mountains.

Distinctiveness

The mountainous terrain is the distinctive feature in this scenic unit. Although the mountains are not high, they possess the most interesting and massive erosional forms in the NPR-A.

3.4.9.2 Visual Sensitivity

Visual resource sensitivity levels indicate the relative interest people have in scenic quality and their concern for change in the existing characteristic landscape. The criteria used in the determination of the visual resource sensitivity levels were use volumes and public attitudes toward change of the landscape character. Sensitivity levels were rated as high, medium, and low and were determined for all of the NPR-A in the 105(c) study.

Since the 105(c) study took place, the BLM has written IAP/EISs for the Northeast and Northwest NPR-A. The 105(c) study found that the area south and west of Nuiqsut had a low sensitivity rating. Information from the 105(c) study was evaluated for the 2008

Northeast NPR-A Supplemental IAP/EIS and determined that the Fish and Judy Creek areas had a high sensitivity level.

The Northwest IAP/EIS in 2003 updated the sensitivity levels of the 105(c) study to high sensitivity for transportation routes: from Barrow to Atqasuk, Barrow to the Ikpikpuk River, Kuk River to Atqasuk to the Ikpikpuk River, Admiralty Bay to Atqasuk, Atqasuk to the southern Meade River and along the coast. The analysis did not change other sensitivity levels in the Northwest NPR-A planning area from those found in the 105(c) study.

For the south portion of NPR-A the 105(c) study found the lands to be of high sensitivity level and review by staff specialists has not resulted in a change. For the current planning effort review by staff specialists have found that there are no low sensitivity levels in the NPR-A. Therefore, those areas not classified as high sensitivity are classified as medium sensitivity. As this planning effort is for the entire NPR-A (as was the 105(c) study), the current map (Map 3.4.9-1) shows the results for all three areas without distinguishing the previous planning borders.

3.4.9.3 Distance Zones

Distance zones are delineated to provide the visual perspective of scale between the viewer and landscape or object being viewed. For the 105(c) study, the NPR-A was divided into three zones as directed by BLM policy: foreground-middleground, background, and seldom-seen.

These distance zones are defined as follows:

- **Foreground-Middleground Zone.** This is the area that can be seen from each travel route for a distance of up to 5 miles where management activities might be viewed in detail.
- **Background Zone.** This is the remaining area that can be seen from each travel route to approximately 15 miles. It does not include areas in the background that are so far distant that the only thing discernible is the form or outline.
- **Seldom-Seen Zone.** These areas are not likely to be seen from travel routes.

The 105(c) study made only the broadest distinctions in distance zones. The northern half of the NPR-A was designated foreground-middleground and most of the south was designated seldom-seen. A stretch of land about 25 miles wide separated the two. They found it impossible to map distance zones in the field due to the lack of conventional transportations systems and to travel the numerous rivers and trails would have required more field time than was available. In planning efforts completed for the northern NPR-A in 2003 and 2008, the BLM reanalyzed distance zones, and as part of the current plan, Arctic Field Office staff analyzed the unplanned portion of the NPR-A. In these reanalyzes, the BLM considered the use of the rivers in the NPR-A to merit that they be the appropriate travel routes from which to evaluate distance zones. The resulting distance zones are displayed on Map 3.4.9-1.

3.4.9.4 Visual Resource Classes

Visual resource classes are categories assigned to public lands that serve two purposes: (1) an inventory tool that portrays the relative value of the visual resources, and (2) a management tool that portrays the visual management objectives (BLM Manual H-8410-1).

Inventory Classes

As discussed above, the 105(c) study identified the scenic quality, sensitivity levels, and distance zones in NPR-A. From this data, visual resource inventory classes (Table 3-34) have been identified for the planning area. Class I is assigned to those areas where a management decision has been previously made to maintain a natural landscape. This includes areas congressionally and administratively designated where decisions have been made to preserve a natural landscape. Classes II, III, and IV are assigned based on combinations of scenic quality, sensitivity levels, and distance zones as shown in the following matrix and as directed in BLM Manual Handbook 8410-1:

Table 3-34. Visual resource inventory classes

		Visual sensitivity						
		High		Medium			Low	
VRM special areas		I	I	I	I	I	I	I
Scenic quality	A	II	II	II	II	II	II	II
	B	II	III	III* IV*	III	IV	IV	IV
	C	III	IV	IV	IV	IV	IV	IV
	Distance Zones	f/m	b	ss	f/m	b	s/s	s/s

*If adjacent areas are Class III or lower assign class III, if higher assign Class IV.
(Source: BLM Manual Handbook 8410-1)

Management Classes

The inventory classes discussed above do not establish management direction. Inventory classes are informational in nature. During the planning process management classes are determined. The management objectives for each class, the level of change allowed, and the relationship to the casual observer are shown in Table 3-35.

3.4.9.5 Visual Resources and Climate Change

If the climate warms in the NPR-A (Scenarios Network for Alaska Planning 2010), scenic quality could be affected. The scenic quality visual elements of vegetation (see section 3.3.1.4) and water (see section 3.3.2.4) could change due to warming. An increase in vegetation height could cause a reciprocal change in distance zones. Taller vegetation could limit what is visible in the foreground and correspondingly shorten the foreground distance and increase the background and/or seldom seen areas. A possible increase in ponds, wetlands and drainage networks would alter distance zones. More waterbodies or larger waterbodies could increase the foreground distance zones and decrease the background and seldom seen distance zones. It is unknown whether an increase in vegetation or an increase in waterbodies would have the greatest impact on distance zones. An increase in both could have a no net affect. If the distance zones change it would correspondently change the inventory class as there is a reciprocal relationship between them.

Table 3-35. Visual resource management class objectives

VRM class	Visual resource objective	Change allowed (relative level)	Relationship to the casual observer
Class I	Preserve the existing character of the landscape. Manage for natural ecological changes.	Very Low	Activities should not be visible and must not attract attention.
Class II	Retain the existing character of the landscape.	Low	Activities may be visible, but should not attract attention.
Class III	Partially retain the existing character of the landscape.	Moderate	Activities may attract attention but should not dominate the view.
Class IV	Provide for management activities which require major modification of the existing character of the landscape.	High	Activities may attract attention, may dominate the view, but are still mitigated.

Information from BLM Manual Handbook 8410-1

3.4.10 Transportation

Transportation systems developed for the Prudhoe Bay Unit and Kuparuk River Unit complex would be the expected source of transportation support for development activities in the planning area. The planning area lies near the western extremity of the Prudhoe Bay Unit/Kuparuk River Unit complex. The Prudhoe Bay and Kuparuk wells are mature producers supported by an extensive network of access roads and crude-oil-gathering lines. This network is constantly expanding as new crude oil production sites are developed. The Alpine Field has brought the expanding North Slope infrastructure to the edge of the NPR-A. Pertinent land routes (Dalton Highway, North Slope oil roads, associated trails, and rights-of-way), airports and airstrips, and cargo-docking facilities are discussed in this section.

Within the external boundary of the NPR-A and on BLM-administered lands, there are limited gravel roads at Umiat and community gravel roads at the four villages of Atqasuk, Barrow, Nuiqsut, and Wainwright. There are few airstrips, and no developed marine facilities along the coastline. Any future oil and gas industry expansion into the NPR-A would extend from existing North Slope infrastructure, either from the existing oil and gas fields near the coast or further inland from the Dalton Highway via future infrastructure such as a proposed road to Umiat under consideration by the state. The Dalton Highway and the Deadhorse Airport may be the primary access routes most of the year for development of the NPR-A.

3.4.10.1 Road Systems

The Dalton Highway (also known as the Haul Road) is a 415-mile-long, north-south, all-weather gravel road connecting Livengood with Deadhorse at Prudhoe Bay. The Dalton Highway is the sole overland route connecting Prudhoe Bay to central and southern

Alaska's other major highway systems. The Dalton Highway is 28-feet wide with an average of 3 to 6 feet of gravel surfacing. In the early years of the road only the portion of the highway from Livengood to the Yukon River Bridge, and later Disaster Creek, was open to the public. In 1995, the Dalton Highway was opened to public access up to the security gates in Deadhorse. Beyond the security gate, the oil field roads are privately owned and maintained. North Slope Borough residents are allowed access to oil field roads to access their communities (via ice roads and snow routes beyond the end of the gravel roads); other members of the public must obtain special approval from North Slope operators.

The main road within the Prudhoe Bay Unit/Kuparuk River Unit complex connecting the Dalton Highway to the oil field infrastructure is the Spine Road. This road crosses through both the western and eastern operating areas of the Prudhoe Bay Oil Field, and provides access from Deadhorse west to the Kuparuk Oil Field Base Camp and east to the Endicott Oil Field. Milne Point and other satellite fields and facilities within the operating areas are connected to the Spine Road. Within Prudhoe Bay's eastern and western operating areas, there are approximately 200 miles of interconnected gravel roads. There are approximately 94 miles of other interconnected roads within the Kuparuk River Unit. There are also 8 miles of causeways providing access to facilities and drilling sites, including the 5-mile-long causeway to the Satellite Production and Main Production Islands at the Endicott Field. Traffic data are not available for the roads within the Prudhoe Bay Unit/Kuparuk River Unit operating area.

Alpine in the Colville River Delta is connected seasonally by an ice road to the Spine Road. Exploratory drilling of the Alpine Satellite Development Project prospect also was assisted by ice-road connections to the Prudhoe Bay Unit/Kuparuk River Unit complex. In addition to the existing gravel roads connecting CD-2 and CD-4 to the Alpine Central Production Facility, ConocoPhillips has proposed more than 20 more miles of gravel roads and a bridge across the Nigliq Channel of the Colville River to link three proposed satellite production pads to Alpine.

In the winter, Nuiqsut is connected to the gravel road system by an ice road. Nuiqsut's gravel road system is limited to connecting the airstrip, housing, and community facilities. However, the North Slope Borough is authorized by the BLM to construct an all-weather gravel road from Nuiqsut south crossing BLM-administered lands to the main channel of the Colville River for local river access. Data are not available for traffic volumes on Nuiqsut's road system. Overland and overwater travel by Nuiqsut residents is achieved year-round by all-terrain vehicles, boats, or snowmachines. Aircraft are also widely used for transportation.

Other North Slope villages are limited to local gravel roads providing access to the airstrip, housing, and community facilities. Overland and over water travel by residents is achieved year round by all-terrain vehicles, boats, or snowmachines. Aircraft are also widely used for transportation.

The State of Alaska is currently studying and planning the Foothills West Transportation Access Project. The state describes the project's purpose as follows: "The purpose of the Foothills West Transportation Access Project is to provide access to oil and gas resources both along the northwestern foothills of the Brooks Range, and within the National Petroleum Reserve-Alaska (NPR-A). The road would provide both exploration and development opportunities for the area as well as facilitate a more economically feasible NPR-A development." (Alaska Department of Transportation 2011). The plan is currently reviewing several possible routes from the Dalton Highway to the Anaktuvuk River, including the proposed route from near Galbraith Lake. The project is proposed to include an all-season road with associated facilities, and multiple material sites. The project would include a bridge over the Colville River immediately south of Umiat with a road into Umiat proper.

West of the Colville River, outside the villages, surface transportation routes for petroleum exploration take the form of ice roads or snow trails. The winter transport routes vary, using nearby lakes as water sources for ice-road construction or follow the coastline on sea ice. Several Alaska Native Claims Settlement Act section 17(b) easements have been reserved across village-owned lands to provide access to public lands.

3.4.10.2 Aviation Systems

There are two major airstrips in the Prudhoe Bay Unit/Kuparuk River Unit area, the state-owned and operated Deadhorse Airport and the privately owned and operated Kuparuk River Unit airstrip. The Deadhorse Airport is served by a variety of aircraft and can accommodate Boeing 737 jet aircraft. The airport consists of a 6,500-feet-long-by-150-feet-wide asphalt airstrip, a small passenger terminal and hangars, storage warehouses, and equipment for freight handling. Alaska Airlines provides commercial air transportation into Deadhorse; annual passenger counts for scheduled flights on Alaska Airlines are estimated at 140,000 people. The Kuparuk River Unit airstrip is owned and operated by Shared Services Aviation. The airstrip is 6,500-feet long and 150-feet wide; it is primarily used by BP's and ConocoPhillips Alaska, Inc.'s Shared Services Aviation, providing scheduled flights several times per week (Morrison 1997). Shared Services Aviation transports only employees, contractors, and cargo. Commercial cargo service is also provided into Deadhorse and to satellite oil field strips. Annual tonnage shipped by air into the Prudhoe Bay Unit/Kuparuk River Unit complex is probably between 250 to 500 tons.

Barrow is the transportation hub for villages on the North Slope. Barrow has a state-owned airport with an asphalt runway approximately 6,500-feet long and 150-feet wide. The Barrow Airport has controlled airspace and is accessible year-round. Available airport services include minor airframe and power plant repairs (U.S. Department of Commerce National Oceanic and Atmospheric Administration 1997). Airport facilities include two large hangars, storage warehouses, and equipment for freight handling.

Nuiqsut is serviced by a 4,500-feet long gravel airstrip located adjacent to the village. The airport is equipped with a rotating beacon, approach lights, high-intensity runway lights, and visual-approach slope-indicator systems. The runway is not attended or monitored (U.S. Department of Commerce National Oceanic and Atmospheric Administration 1997). The community is served by twice-daily flights from Barrow and Deadhorse carrying passengers, cargo, and mail. Chartered aircraft also use the airport on a regular basis.

Unattended gravel runways serve the communities of Wainwright and Atqasuk. The Wainwright airstrip is 4,500-feet long and 90-feet wide while the Atqasuk airstrip is 4,370-feet long and 110-feet wide (U.S. Department of Commerce National Oceanic and

Atmospheric Administration 1997). Each airport is also equipped with a rotating beacon, approach lights, high-intensity runway lights, and visual-approach systems.

A 5,000-feet-long gravel airstrip owned by ConocoPhillips Alaska, Inc. is located at the Alpine Field near pad CD-1. It is used to support oil field activities. It will most likely be used to support future exploration, development, and production projects in the Greater Mooses Tooth and Bear Tooth units.

The majority of summer flights occur in the vicinity of Nuiqsut/Alpine, Ivotuk, Umiat, and Inigok, with some flights coming out of Barrow, Atqusuk and Wainwright. Beginning in the summer of 2008, the BLM has implemented a flight following process with all authorized helicopter landings and takeoffs north of latitude 70° North in the NPR-A. This process is a result of the programmatic consultation the BLM conducts each spring with the U.S. Fish and Wildlife Service per the Endangered Species Act. The data has shown a concentration of flight paths around winter and summer oil and gas project areas. There are a large number of landings and takeoffs associated with a typical flight, i.e., most helicopter flights in the summer are not long distance, but rather short hops highly concentrated in exploration projects in the Fish Creek, Judy Creek, and Tingmiagsivik (Ublutuoch) River drainages and the Simpson Peninsula area. For aircraft operating south of latitude 70° North, the BLM monitors its own contracted helicopters and any other aircraft that uses the Automated Flight Following system. Aircraft are reaching all parts of the NPR-A for a variety of purposes: recreation, research, land management, and industry-related activities. Several commercial air taxis and transporters fly guides and visitors into remote areas to backpack, hunt, and float rivers primarily on the Colville, Etivluk, Nigu and the Utukok rivers.

Winter flight operations in the NPR-A are based on scheduled commercial flights in the communities, and project-specific operations. There have been four areas of exploration in the NPR-A in the last decade near Nuiqsut, Umiat, Simpson Peninsula, and Barrow. These projects have made use of local permanent airstrips, such as Cape Simpson, Lonely, or Barrow, but have relied upon remote airstrips on frozen lakes when permanent facilities are too far away. The air traffic may be intense during mobilization or demobilization periods, or other times when overland transportation is limited due to a variety of constraints.

3.4.10.3 Water Transportation Systems

Marine transportation on the North Slope generally is freight oriented with the exception of relatively small, inboard and outboard engine watercraft used by villagers and less frequently for scientific research. Marine transportation on the North Slope is used to bring in fuel, freight, and prefabricated facilities for communities and the region's oil and gas exploration activities.

Marine shipments to the North Slope are limited to a seasonal window between late July and September, when the Arctic coast is ice-free. Port facilities on the North Slope range from shallow-draft docks with causeway-road connections, to facilities located at Prudhoe Bay, to beach-landing areas in North Slope communities and remote project areas such as Point Lonely and Cape Simpson. Because there is no deepwater port, cargo ships, and oceangoing barges are typically offloaded to shallow-draft or medium-draft ships for lightering to shore. Smaller craft also are used to transport cargo upriver.

There are three dockheads for unloading barges at Prudhoe Bay. A 1,100-foot-long causeway connects East Dock to a 100-foot-wide-by-270-foot-long wharf constructed from grounded barges; this dock is no longer used (U.S. Department of Defense et al. 1984). West Dock, a 13,100-foot-long by 40-foot-wide, solid-fill, gravel causeway is located along the northwestern shore of Prudhoe Bay east of Point McIntyre. There are two unloading facilities off the gravel causeway at West Dock. One facility is located 4,500 feet from shore and has a draft of 4 to 6 feet. The second facility is located about 8,000 feet from shore and has a draft of 8 to 10 feet. Water depths around the causeway average 8 to 10 feet.

There is another dock at Oliktok Point extending 750 feet from the original shoreline. At the dockface, the water depths reach 10 feet while at the bottom of the dock's boat ramp water depths draw at least 5 feet. The Oliktok facility also doubles as a seawater-treatment plant (Rookus 1997).

There are no port facilities in Barrow. Supplies and cargo are brought into the area by barges and larger cargo ships and taken to shore by smaller vessels. Supplies either are offloaded directly onto the beach or are lifted off the vessel by crane. The primary area used for offloading supplies is located north of the community.

There are no port facilities in Wainwright. Supplies and cargo are typically brought into the area by barges and larger cargo ships and taken to shore in Wainwright Inlet by smaller vessels. Supplies are offloaded onto the beach in large containers. The beach landing area is constructed to assist in stabilizing the vessels as cargo is unloaded or loaded. Large fuel vessels are anchored off shore in the Chukchi Sea at Wainwright and transfer fuel via large hoses to onshore fuel containment.

Nuiqsut is located roughly 18 miles upriver from the sea on a channel of the Colville River. Supplies and cargo are brought to the shoreline of the Beaufort Sea by barges and larger cargo ships and then taken upriver by smaller vessels.

Local residents travel via small vessels along the Chukchi Sea shoreline, inside the barrier islands along the Beaufort Sea, up streams and into Teshekpuk Lake to access their cabins, fish camps, Native Allotments and/or recreational opportunities. The vessels may be oceangoing V-hulled boats either propeller or jet driven, small to medium riverboats either propeller or jet driven, or airboats. It is common for people to travel up the Kuk River and associated tributaries in the Wainwright area, the Meade River and associated tributaries, the Chipp and Ikpikpuk rivers area and tributaries, Teshekpuk Lake, the coastal water, the Colville River delta, the Colville River and tributaries far upstream of Umiat.

3.4.10.4 Pipeline Systems

Several major trunk pipeline systems carry crude oil to the Trans-Alaska Pipeline System from Prudhoe Bay East, Prudhoe Bay West, Milne Point, Endicott, Lisburne, Kuparuk, Badami, and the Alpine Field. These systems total approximately 415 miles. All of these pipelines are built aboveground, elevated on vertical support members except for select stream crossings where the pipelines may go under the stream. There are numerous production pad feeder lines serving each of these oil transit lines. Often pipelines are "bundled" with different crude and non-crude carriers occupying the same right-of-ways. Access roads run along each of the pipelines, except those from the Badami and Alpine fields, to provide for operations, maintenance, and repair.

If development occurred in NPR-A, one or more new pipelines would be constructed to carry oil or gas from the Reserve to existing pipeline systems in the case of oil or to commercial gas infrastructure that may be developed in the future to the east of NPR-A. Development in the southern portions of NPR-A may utilize yet to be constructed pipelines eastward to the Trans-Alaska Pipeline System or a new commercial gas pipeline or send resources northward to use existing infrastructure in the Alpine, Kuparuk, and Prudhoe Bay area. Development in the northern part of NPR-A would likely use the existing infrastructure at Alpine, Kuparuk and Prudhoe Bay. Oil produced from the Alpine Field is transported from the Alpine Field to Kuparuk River Unit through a 14-inch diameter, 35-mile-long pipeline. This pipeline from Alpine Field CD-1 is carrying 90,000 barrels of oil per day (2010) to Kuparuk River Unit and then on to Trans-Alaska Pipeline System Pump Station 1. The transport of oil from the planning area through this pipeline would depend upon the future production rates of the Alpine Field and the capacity of the Alpine Field sales oil line at the time oil was transported from the planning area. If the Alpine Field sales oil line has insufficient capacity to carry oil from the planning area, a new pipeline would be constructed between the Alpine Field and Kuparuk River Unit to carry oil from the planning area. The pipeline would likely follow existing pipeline and road right-of-ways. From Kuparuk River Unit, the oil would be transported to Trans-Alaska Pipeline System Pump Station No. 1 through the 22-mile-long Kuparuk pipeline. Production from the Alpine Field, as well as additional discoveries in the NPR-A, could create a product flow in excess of the Kuparuk line's carrying capacity.

From Pump Station No. 1, the Trans-Alaska Pipeline System heads south for over 800 miles to an oil-trans-shipment terminal located at Valdez on Prince William Sound. The oil pipeline is 48 inches in diameter with a 30-foot-wide access road and work pad running adjacent to it. The Trans-Alaska Pipeline System throughput capacity is approximately 2.1 to 2.2 million barrels per day. Currently, Trans-Alaska Pipeline System throughput is about 630,000 barrels per day. The Trans-Alaska Pipeline System and Valdez Marine Terminal are completing a strategic reconfiguration. The Valdez Marine Terminal has 18 crude-oil-storage tanks with a total capacity of 9.18 million barrels per day.

3.4.10.5 NPR-A Facilities

Transportation facilities within the NPR-A are few. Outside airstrips and other infrastructure available in the villages of Atqasuk, Barrow, Nuiqsut, and Wainwright, the only facilities are those at associated with earlier government oil and gas exploration sites, at Point Lonely, Umiat, Ivotuk and Inigok. Other airstrips, such as those at former Distant Early Warning-Line stations at Cape Simpson, Wainwright, Kogru River, and Icy Cape, and older oil and gas exploration sites such as Oumalik, Tunalik, and Driftwood are typically no longer accessible due to the lack of maintenance.

At Lonely, there is a deactivated, remote-controlled United States Air Force Distant Early Warning-Line station that has been used as an oil field-support base starting during the U.S. Navy exploration periods of the 1950s, 1960s, and 1970s, up to the present. A second site in the Lonely/Pitt Point area is a 15 acres gravel pad under lease from BLM to the

Cook Inlet Regional Corporation and located approximately 1 mile west of the Distant Early Warning-Line station. Both the Distant Early Warning-Line station and the Cook Inlet Regional Corporation gravel pad may be accessed by the 5,200-foot airstrip at the station. Currently, there are no other facilities in the Lonely/Pitt Point area.

The Umiat facility is a public airstrip operated by the State of Alaska. During summer months, the airstrip is maintained by Umiaq, a private contractor, and there is little consistency in seasonal periods of operation.

Inigok is located at a former Husky Oil drilling site. The airstrip, estimated to be 5,000-feet long by 140-feet wide, was constructed in 1977 and is an insulated gravel airstrip. Approximately 1 foot below the gravel surface, the runway is underlain by polystyrene foamboard. Below the foamboard to a depth of 6 feet from the runway top is a layer of permanently frozen sand fill (Kachadoorian and Crory 1988). Due to the nature of its construction, the Inigok strip remains useable approximately two decades after its abandonment and is used by the BLM during the spring and summer seasons as a base camp for field operations. The airstrip and apron areas are in need of maintenance with new gravel and grading. The airstrip suffers numerous soft spots in the middle and the apron has numerous holes that pose a threat to aircraft. The airstrip is limited to aircraft no larger than a DC-4.

3.4.10.6 Overland Travel

Local residents have regularly traveled across the entire Alaska North Slope for a long time. Summer travel in the past was typically restricted to the ocean and streams with little overland travel. It was during the winter season that overland travel was more common with the use of dogsleds. Today, residents travel overland year-round. There are numerous trails emanating out from communities. Some trails were originally created by the U.S. Navy, while others were created by local use with the introduction of all-terrain vehicles or off-highway vehicles. The use of four-wheelers is the main mode of transportation during the summer months by local residents. There may be hundreds of miles of four-wheeler trails in the NPR-A on conveyed lands and BLM-administered lands. Most trails will lead to Native Allotments, cabins, or fish camps.

Local winter overland travel is primarily done with snowmachines, though other types of vehicles are being used. Snowmachine travel can be for recreational use, more traditional uses such as to Native Allotments, cabins or trapping areas, or for inter-community travel across the Alaska North Slope. For example, it is common for people to travel between Barrow and Nuiqsut by snowmachine throughout the winter. It is even more common for people to travel between Barrow and Atqasuk during the winter. With the technological improvements in snowmachines, people are expanding their travel routes farther from home with more regularity and intensity of use than what may have been in the past.

During exploration projects on the Simpson Peninsula and south of Barrow in the recent past, well established snow trails and ice roads were constructed by companies from permanent infrastructure in the Kuparuk Field area. During this period, people in Barrow drove common personal vehicles (cars and pick-up trucks) on these snow trails and ice roads. Some drove newly purchased vehicles from Fairbanks to Barrow. After the exploration projects ended, people began to use the Rolligon trail from the Nuiqsut area to Barrow and Atqasuk to drive new vehicles to Barrow.

Since 1983, ice bridges have been constructed across the Colville River. The first bridge was built to facilitate oil and gas exploratory drilling. The second bridge, built by the people of Nuiqsut in 1984, helped the village respond to a fuel crisis (Smythe et al. 1985). Since then, villagers or ConocoPhillips have annually constructed an ice road from Nuiqsut to Oliktok or the nearest oil-exploration ice road, whichever is closer. The road is created by blading the snow off the river's ice cover, once sufficient thickness has been reached. The road is used for the overland transport of fuel and other material; it also gives the residents access to the Dalton Highway through the established oil field roads. Beginning in the mid-1990s, ConocoPhillips has built the ice road from Nuiqsut to Kuparuk and Alpine most years.

Starting in the 1940s, with the intensive oil and gas exploration by the U.S. Navy, hundreds of miles of overland trails were created. Most trails were commonly created by scraping the topsoil off with a dozer in an attempt to create an established trail, just as one would in more mid-latitude climates without permafrost. Winter trails were also created, though not always by the same method as for summer trails. These winter trails are commonly depicted on some topographical maps. These trails traversed across the Alaska North Slope, including most of the NPR-A. Most trails started from Barrow, Cape Simpson, or Umiat. From these locations, the trails emanated out to places such as Square Lake, Oumalik, Brady, Driftwood Creek, Lonely, the upper Meade River, the upper Ikpikpuk River, the upper Utukok River and the Colville River drainage. Most of the trails are still visible and at times used by present-day projects.

Most ice roads and snow trails in the NPR-A are constructed in support of oil and gas operations. Snow trails also have been constructed to deliver supplies from Deadhorse to communities, such as Barrow and Atqasuk. In the past decade, the miles of packed snow trails have far exceeded those of ice roads. Cost, time to build, availability of water sources and topography appear to limit usage of ice roads. These numerous routes are usually over previously used winter trails. These are not to be construed as public roads and the holder of the right-of-way is held accountable by the BLM for any tundra damage that might occur.

Umiat has been accessed via snow trails and ice roads in the past 5 years for oil and gas exploration projects in the area. Such routes have started at either Pad 2P in the Kuparuk River Unit or Sagwon along the Dalton Highway. Given the topography in the foothills around Umiat, the use of ice roads is less viable than the use of snow trails for numerous reasons, such as slope, project distances, snow depths, lack of surface water sources, and less wind than along the coastal plain.

Seismic exploration with Rolligon and track vehicles also occurs in the NPR-A periodically as industry considers necessary to identify oil and gas prospects. Seismic operations require a great deal of resources and therefore a lot of vehicles and overland transportation.

3.4.10.7 Transportation and Climate Change

Transportation on the Alaska North Slope is a process of continual change due to a variety of influences, including environmental conditions, mercurial economics, technological advances, social values, and regulatory requirements. With projections to 2099 for shorter and warmer winters, longer and warmer summers, more snow and rain, and a deeper active layer, transportation on the Alaska North Slope will have to change. In order to accommodate shorter winter seasons, there have been technological and methodological advances, and regulatory changes in snow trail and ice road construction. The State of Alaska is managing a summer overland travel program as part of their response to shorter winter travel seasons. It is anticipated that technological and methodological advances will continue to meet ever-changing demands. If temporary transportation projects become unviable in the future, it may be necessary to reevaluate the use of a more permanent transportation infrastructure.

3.4.11 Economy

The planning area is entirely contained within the North Slope Borough; however, the relevant economic area must be understood at multiple levels. Four communities, Nuiqsut, Barrow, Wainwright, and Atqasuk, lie within the planning area, and are the primary villages for economic effects of BLM management decisions. Other villages in the North Slope Borough may experience less intense effects in matters such as subsistence or borough revenues from NPR-A activities. The least intense economic effect considered in this analysis will be other regions of the State of Alaska, including Fairbanks and southcentral Alaska. Many North Slope oilfield workers live in and around Anchorage, and some of the manufacturing and retail activities used by North Slope communities are headquartered in the same area, with additional sources in Fairbanks. The State government receives tax and revenue sharing from NPR-A oil-related activities. National and international effects are substantially diluted by resources and activities elsewhere, so they will not be addressed.

The North Slope Borough is a regional market economy built around the development of a single resource with few alternatives to diversify. The North Slope Borough is unique because of limited opportunities for residents to share in the economic activity of oil production and the relative lack of private industry outside of North Slope oil production enclaves.

For a detailed description of the area's economic history and trends, see "North Slope Economy, 1962-2005," which is incorporated by reference (USDOI Minerals Management Service 2004).

3.4.11.1 Economic Structure and Demographics

The North Slope Borough includes the entire northern coast of Alaska and encompasses almost 90,000 square miles, or about 15 percent of the land area of Alaska. The passage of the Alaska Native Claims Settlement Act in 1971, formation of the North Slope Borough in 1972, and development of the oil field at Prudhoe Bay beginning in 1977 have all influenced the economic structure of the North Slope. The region engages in a mixed economy, with traditional subsistence adapting to and benefitting from employment, capital ownership, and governmental transfers generated by market activities. This section addresses the currency-denominated economy with emphasis on personal income and governmental revenues. For information on subsistence activities, see section 3.4.3. For information on sociocultural values of the subsistence lifestyle, see section 3.4.4. There is no quantitative estimation of nonmarket values or ecosystem services and no benefit/cost analysis presented because issues raised did not require such analysis and the analysis is not required by laws applying to this IAP/EIS.

Oil is the mainstay of the Alaskan and North Slope market economies, and oil property taxes are the primary source of revenues for the North Slope Borough. The Borough provides a wide range of public services to all of its communities and is the primary employer of local Alaska Native residents, followed by Alaska Native Claims Settlement Act regional and village corporations.

The Arctic Slope Regional Corporation is owned by and represents the business interests of the Arctic Slope Iñupiat. There are currently 11,000 enrolled shareholders. The 2010 spring and fall dividends totaled $64.26 per share. Most shareholders have 100 shares, resulting in an annual payout of $6,426 per shareholder. Shareholders represent a small portion of Arctic Slope Regional Corporation's 6,600 employees worldwide.

A substantial increase in North Slope Borough services since formation has improved the quality of life for residents of the North Slope Borough in terms of infrastructure, safety, medical care, and educational opportunities (Kruse 1991). The related increase in jobs provided a rapid improvement in economic well-being beginning in the 1970s, followed by a shift in demographics. Population on the North Slope more than doubled between 1970 and 2000, from 3,075 to 7,385, which is a slightly higher rate than Alaska's increase from 300,382 to 626,932 (U.S. Census Bureau 2000). The 2010 census reported the North Slope Borough population at 9,430 including 2,174 at Prudhoe Bay (largely not previously included in North Slope Borough totals, as explained on page 11 of Goodman [2011]). Village population is 7,166 or a decline from 2000 of about 3 percent. This compares to a population for the state of 710,231 and an increase from 2000 of 13 percent (Alaska Department of Labor and Workforce Development 2011). See Table 3-36 for population trends of North Slope Borough, selected communities, and the state.

Table 3-36. Population of selected locations in Alaska

Community	Year					
	1960	1970	1980	1990	2000	2010[3]
North Slope Borough[1]	2,133	2,663	4,199	5,979	7,385	9,430
Nuiqsut[1]	-	-	208	354	433	402
Barrow[1]	1,314	2,104	2,267	3,469	4,581	4,212
Wainwright[1]	253	315	405	492	546	556
Atqasuk[1]	-	-	107	216	228	233
Prudhoe Bay (per Census)	0	49	50	47	5	2,174
Municipality of Anchorage[1]	82,833	126,385	174,431	226,338	260,283	291,826
Fairbanks North Star Borough[1]	43,412	45,864	53,983	77,720	82,840	97,581
Alaska[2]	226,167	300,382	401,851	550,043	626,932	710,231

1. Source: Alaska Department of Commerce, Community, and Economic Development
2. USDOC Bureau of the Census
3. ADOLWD, 2010 Census

After formation of the North Slope Borough, the improved conditions brought by capital projects and employment opportunities in some of the smaller communities brought some people back to their villages from larger population centers, such as Barrow (USDOI BLM and Minerals Management Service 2003). The traditional encampments of Nuiqsut, Atqasuk, and Point Lay were resettled in the 1970s. The return to small traditional villages reflected preferences of many Iñupiat for a more rural lifestyle when modern public services and facilities, education, and opportunities for employment were also available. However, over half of the North Slope Borough's village population continues to live in Barrow. Prudhoe Bay oilfield enclaves constituted 23 percent of the North Slope Borough population in the 2010 census.

Another factor that contributes to population increase, particularly in Barrow, is the in-migration of non-Iñupiat into the North Slope Borough. The percentage of non-Natives in the population of the North Slope Borough increased from 17 percent in 1970 to 27 percent in 1990 and 26 percent in 2000 (U.S. Census Bureau 2000). The 2010 census indicates 41.5 percent of North Slope Borough does not identify themselves as all or part Alaska Native. Excluding Prudhoe Bay, the non-Native population represents 27 percent of the 2010 village population in North Slope Borough (Alaska Department of Labor and Workforce Development 2011).

Beginning in the mid-1970s, employment opportunities in the oil and gas and construction sectors resulted in an influx of nonresident workers on the North Slope. While total earnings in the region increased significantly during this time, nonresidents earned most of these dollars and did not respend them in the local economy. However, indirect effects from government expenditures and oil and gas development expanded the private support sector (e.g., trade, utilities, telecommunications, finance, insurance, and real estate). Oil field activities, public expenditures, and the construction sector remain the primary economic drivers in the region.

The North Slope Borough is also experiencing out migration of its residents to urban areas, caused predominantly by the pursuit of economic and education opportunities. According to a study by the Institute of Social and Economic Research, the North Slope experienced net migration (in migration minus out migration) of about -22 percent from 2000 to 2007 (Martin et al. 2008).

While household and per capita incomes have increased in the North Slope villages, the high costs of living in the region offset the increases to some extent. Subsistence resources continue to be of economic and cultural importance to residents, but the adoption of modern technology has raised the monetary cost of participating in subsistence activities.

The market and transfer economies of North Slope Borough primarily rely on one resource (oil), and BLM land management decisions made in conjunction with this plan will affect that resource. This makes community resilience (the ability to cause or adapt to change) a relevant concern in evaluating local effects. Kruse (1991) identified several factors that contributed to the area's ability to adapt to change brought buy the oil development activities at Prudhoe and other fields. Organizing and using the North Slope Borough to address community needs was a large factor in that adaptation and it is appears that continued success will be driven by this factor.

Demographic factors may indicate a community's economic resilience. Age may be an indicator of economic vulnerability for either children or elderly residents. Median age can indicate can be an indicator of a stable population aging in place or of the relative flows in and out of a community, particularly where age cohorts move away to pursue education, employment, or retirement amenities. The 2000 census indicated the median age was 27. A decade later, the 2010 census indicates median age for the borough of about 35 years when the Prudhoe Bay oilfield worker as a whole and lower than Anchorage or Fairbanks North Star Borough counted as North Slope Borough residents are included. When the Prudhoe Bay data (median age of 49) are excluded, the North Slope Borough village median age is less than 30—lower than for the state. This alone does not indicate a similar age mix as in 2000, but suggests a large portion of younger members.

Table 3-37 and Table 3-38 summarize several social and economic statistics for North Slope Borough, selected communities in the planning area, Anchorage, Fairbanks, and the State of Alaska.

Table 3-37. Summary of socioeconomic characteristics in 2000

Location	Population	Median age	Alaska Native residents (%)	Average household size	Families in poverty (%)	Un-employment (%)	Non-military labor force participation (%)
North Slope Borough	7,385	27.0	68.4	3.5	8.6	10.8	72.2
Nuiqsut	433	23.8	88.2	3.9	3.2	6.4	73.1
Barrow	4,581	28.8	57.2	3.3	7.7	9.4	74.2
Wainwright	546	24.5	90.3	3.7	8.5	14.8	67.8
Atqasuk	228	26.3	94.3	4.2	25.0	3.3	57.9
Anchorage	260,283	32.4	7.3	2.7	5.1	4.7	74.4
Fairbanks North Star Borough	82,840	29.5	6.9	2.7	5.5	5.8	74.2
Alaska	626,932	32.4	15.6	2.7	6.7	6.1	71.3

Source: Census 2000

Table 3-38. Summary of socioeconomic characteristics in 2010

Location	Population	Median age	Alaska Native residents (%)	Average household size
North Slope Borough	9,430	35.1	58.5	3.30
Nuiqsut	402	25.2	89.6	3.47
Barrow	4,212	28.0	68.6	3.26
Wainwright	556	27.6	91.7	3.65
Atqasuk	233	24.3	93.1	3.64
Prudhoe Bay	2,174	49.1	8.6	0.00
Anchorage	291,826	32.9	12.4	1.60
Fairbanks North Star Borough	97,581	31.0	10.9	2.56
Alaska	710,231	33.8	19.5	2.70

Sources: ADOLWD (2011), database from U.S. Census 2010; and Goodman (2011)

Workforce age composition can indicate the ability of members to exploit new employment opportunities, including training for new careers. Age distribution for North Slope Borough villages in 2010 indicates 35 percent of the village population was less than 20 years old, while 3 percent was over 60 (Table 3-39). Hence, a much larger component of the population will be seeking training and initial job opportunities than those who will be near the end of their careers or retired during the next 15 years. The remaining 62 percent were between 20 and 59 years. For Prudhoe Bay, 90 percent of the population is between 20 and 59, with few below and nearly 10 percent over 60. The largest Prudhoe Bay cohort is 50 to 54 while the largest village cohort is under 5-years old. (Alaska Department of Labor and Workforce Development 2011 and Alaska Department of Commerce, Community, and Economic Development 2011). Comparison to village age cohorts in 2000, when the largest cohort was aged 10 to 14 years (now 20 to 24), indicates that that cohort is second largest in 2010, but it has lost about 25 percent (over 200 members) to out-migration or death.

Table 3-39. Age distribution in the North Slope Borough

Age cohort (years)	Village		Prudhoe Bay	
	2000	2010	2000	2010
Under 5	705	747		
5 to 9	780	620	2	
10 to 14	862	553	1	
15 to 19	721	624		5
20 to 24	448	640		112
25 to 29	459	558		192
30 to 34	530	435		215
35 to 39	595	378	2	207
40 to 44	636	452		186
45 to 49	507	583		254
50 to 54	390	556		418
55 to 59	266	473		366
60 to 64	173	281		173
65 to 69	119	153		38
70 to 74	82	82		8
75 to 79	58	53		
80 to 84	32	47		
85 and over	17	21		

Sources: Alaska Department of Commerce, Community, and Economic Development (2011) and Alaska Department of Labor and Workforce Development (2011).

Common cultural values may influence attitudes and reactions to change, or social cohesiveness. As shown in Table 3-38 on page 476, Alaska Natives represent a larger share of the population in village North Slope Borough than the total state, Anchorage, or Fairbanks North Star. Barrow has over 68 percent Alaska Native residents, the lowest for a community in North Slope Borough, other than Prudhoe Bay. This would suggest most communities in North Slope Borough have a majority of residents with a common culture and heritage that may lead to more cohesive community attitudes and reactions to change.

Household size, poverty, and unemployment can signal economic stress within communities and are possible economic indicators for monitoring the economic well-being of a region. Household size is larger, there are more families in poverty, and unemployment is higher in North Slope Borough than in the other two relevant boroughs and in the state as a whole. While household size may relate to cultural norms or the lower median age, it may also reflect the cost of maintaining a household. Within the North Slope Borough, the families in poverty in 2000 ranged from 3 percent in Nuiqsut to 25 percent in Wainwright, with a borough average of almost 9 percent. Similarly, unemployment ranged from 3 percent in Atqasuk to nearly 15 percent in Wainwright, compared to the borough average of nearly 11 percent. Statewide unemployment in 2000 averaged 6.1 percent.

North Slope Borough labor force participation, at 72 percent in 2000, is about the same as the average for Alaska, and a bit below Anchorage and Fairbanks North Star Borough rates of over 74 percent. Atqasuk had the lowest participation rate at 58 percent, which may explain the low unemployment rate there. However, Wainwright had 68 percent participation and still reported a much higher unemployment rate. Participation in Barrow was the same as Anchorage and Fairbanks North Star Borough.

3.4.11.2 Employment

Table 3-40 provides information by industry for workers employed in the North Slope Borough. The two largest employment sectors are mining (including oil & gas extraction) (60 percent) and local government (12 percent). The number of workers in the North Slope Borough is nearly double the total population of the region, largely filled by nonresident workers.

Mining (including Oil and Gas)

Oil industry employment has a very narrow definition, and as a result, many of the thousands of jobs that service the oil and gas industry are not classified as oil industry employment shown as "Mining" in the table above. Support jobs include catering, security, construction contracting, transportation, engineering, and other support services and are included as part of the Table 3-40. However, additional information would be required from individual employers to identify and sum the specific jobs supporting oil and gas activities within the broader categories for any given year. It is estimated that for each direct job created by future Outer Continental Shelf activity in the oil and gas sector, and the revenues associated with production, an additional 4.8 indirect jobs are created in the Alaskan economy in the form of infrastructure, support, and state and local government employment (Northern Economics and Institute of Social and Economic Research 2009). It may be that there is a similar increase for onshore activities within NPR-A.

While Alaska produces 15 percent of domestic oil (U.S. Department of Energy Information Administration 2011 and Alyeska Pipeline Co. 2011), it does so with only 2.6 percent of the industry's U.S. workforce. Larger fields do not necessarily need more workers than small fields. Economy of scale is one of the reasons for the state's relatively small oil field workforce. Prudhoe Bay, the largest oil field in the nation, accounts for 45 percent of the North Slope's production. Kuparak is the second largest field in Alaska, followed by the Alpine Project near Nuiqsut. The cost to transport workers, equipment, and supplies to many of Alaska's smaller North Slope oil fields means they are marginal or noneconomic, though they would be viable in a more populated, less remote environment.

Table 3-40. Total employment in North Slope Borough by industry (North American Industrial Classification System)

Industry	2001	2008	2008 Share of total (%)	New jobs
Forestry, fishing, related activities	25	25	<1%	0
Mining (including oil and gas)	4,311	8,342	60%	4,031
Construction	N/A	272	2%	N/A
Manufacturing	N/A	12	<1%	N/A
Wholesale trade	5	N/A		N/A
Retail trade	361	267	2%	(94)
Transportation and warehousing	223	207	1%	(16)
Information	N/A	50	<1%	N/A
Professional and technical services	191	N/A		N/A
Administrative and waste services	605	1,136	8%	531
Arts, entertainment, and recreation	91	N/A		N/A
Accommodation, and food services	327	N/A		N/A
Other services (except public administration)	202	293	2%	91
Government; Federal, civilian	21	24	<1%	3
Government; Military	47	46	<1%	(1)
Government; State	58	64	<1%	6
Government; Local	1,882	1,693	12%	(189)
TOTAL	9,593	13,829		4,236

Source: U.S. Department of Commerce Bureau of Economic Analysis (2010).
Note: N/A indicates data not disclosed by the Bureau of Economic Analysis.

Local Government

A goal of the North Slope Borough is to create employment opportunities for Alaska Native residents, and it has been successful in hiring Alaska Natives for borough construction projects and operations, including education, safety, and medical services. The North Slope Borough employs many permanent residents directly and finances construction projects under its Capital Improvement Program, which employs additional North Slope Borough residents. As a result, the government itself is viewed as the primary employer for North Slope Borough residents.

The government sector in the North Slope Borough, including education, supported 56 percent of resident employment in 1980, increasing to about 70 percent by 1993, and about 61 percent of jobs in 2003 (USDOI Minerals Management Service 2006).

North Slope Oil Industry Employment of North Slope Borough Residents

Very few Alaska Native residents of the North Slope have been employed in oil-production facilities and associated work in and near Prudhoe Bay since production started in the late 1970s. This has been a continuing concern of North Slope Borough residents and is significant when assessing the potential economic effects of proposed oil and gas exploration and development on the North Slope Native population. A primary factor is the low local hiring of the oil and supporting industries.

However, while local residents occupy only a minor percentage of the direct oil and gas jobs, they hold an unknown percent of indirect jobs in other sectors of the economy that provide goods and services to oil and gas activities through support contracts for North Slope and Outer Continental Shelf projects (Northern Economics Inc. and Institute of Social and Economic Research 2009).

Several programs have been initiated over the years to increase the North Slope Borough Native employment in the oil and gas industry. BPXA's Itqanaiyagvik Program is a joint venture with the Arctic Slope Regional Corporation and its oilfield subsidiaries, and is being coordinated with the North Slope Borough and the North Slope Borough's School District (BPXA 1998 and UA 2001). Nanook Incorporated, a subsidiary of Kuukpik Corporation, based in Nuiqsut, has a training program for positions in the oil industry, such as technicians and other long-term jobs (Helms, as cited in USDOI Minerals Management Service 2003). The Alaska Processing Industry Careers Consortium (2011) at the University of Alaska is another program available to North Slope Borough residents that seeks to create and enhance the quality of training programs available to prepare Alaskans throughout the state for careers in the processing industry, including oil and gas production. The Consortium currently manages the North Slope Training Cooperative.

The North Slope has the highest concentration of oil industry workers in the state, accounting for nearly half of the North Slope's wage and salary employment. In 2006, the Alaska Department of Labor reported 9,415 total workers in the private sector on the North Slope. Only 14.1 percent of these were borough residents, 57.4 percent resided in other parts of Alaska, and 28.5 percent were not Alaska residents (Hadland 2006). Table 3-41 provides employment by sector for employed residents of the North Slope Borough, selected communities, and Alaska in 2000.

3.4.11.3 Unemployment

In simple terms, unemployment rates are calculated by dividing the number of people looking for work by the total number of available workers in the labor force. Unemployment rates in the double digits usually indicate a depressed or stagnant economy, while a rate under 4 percent is considered full employment. However, there are limitations in interpreting this information, because no differentiation can be made between full-time and part-time jobs. In addition, it does not account for individuals who are underemployed (employed part-time but seeking full-time position) or discouraged (involuntarily unemployed, but no longer actively seeking employment).

Table 3-42 shows employment and unemployment for residents of the North Slope Borough, other relevant boroughs, and the State of Alaska as of 2010. The unemployment rate is lowest in the North Slope Borough at 5.6 percent during 2010, while the statewide unemployment is over 7 percent.

Table 3-41. Resident employment by sector

Industry	North Slope Borough	Nuiqsut	Barrow	Wainwright	Atqasuk	Anchorage	Fairbanks North Star	Alaska
Agriculture, forestry, fishing and hunting, and mining	63	6	38	5	-	3,886		13,774
Construction	237	43	103	11	12	7,995	930	20,534
Manufacturing	12	-	9	3	-	2,542	3,028	9,220
Wholesale trade	8	-	3	1	-	4,428	772	7,215
Retail trade	190	13	123	14	2	15,327	757	32,638
Transportation, warehousing, and utilities	282	24	167	21	8	11,809	4,365	25,043
Information	43	2	38	1	-	4,079	3,085	7,652
Finance, insurance, real estate, and rental and leasing	74	-	62	2	5	7,654	835	12,934
Professional, scientific, management, administrative, and waste management services	98	-	85	1	-	12,845	1,432	21,322
Education, health, and social services	1,017	37	718	60	16	24,532	2,336	61,165
Arts, entertainment, recreation, accommodation, and food services	97	5	57	15	-	11,342	8,966	24,099
Other services (except public administration)	179	12	136	6	10	7,156	3,182	15,866
Public administration	690	34	447	64	13	12,142	2,116	30,070
TOTAL	2,990	176	1986	204	66	125,737	35,258	281,532

Source: U.S. Department of Commerce Bureau of the Census (2000)

Table 3-42. Annual average labor force statistics for 2010

2010	North Slope Borough	Anchorage	Fairbanks North Star	Alaska
Labor force	4,917	154,878	45,785	364,506
Employment	4,640	144,423	42,810	337,734
Unemployment	277	10,455	2,975	26,772
Rate (%)	5.6	6.8	6.5	7.3

Source: Alaska Department of Labor and Workforce Development (2010)

Table 3-43 presents labor force, employment, and unemployment data for the North Slope Borough over time. The table is included to show employment and unemployment trends for residents of the Borough. The unemployment rate nearly tripled between 1990 and 2005. In 1990, the North Slope Borough unemployment rate was 3.5 percent, the lowest rate in the last 25 years. Recently, the rate dropped between 2005 and 2009, despite a labor force increase of 38 percent during that time. Note that the population was declining during that time.

Table 3-43. Annual average labor force statistics for the North Slope Borough

	1990	1995	2000	2005	2006	2007	2008	2009	9/2010
Population				6,899	6,811	6,726	6,703	6,798	
Labor force	2,817	3,168	3,396	3,716	4,147	4,695	5,140	5,394	4,917
Employment	2,717	3,054	3,118	3,382	3,867	4,452	4,959	5,140	4,640
Unemployment	100	114	278	334	280	243	211	254	277
Rate (%)	3.5	3.6	8.2	9.0	6.8	5.2	4.1	4.7	5.6

Source: Alaska Department of Labor and Workforce Development (2010)

3.4.11.4 Personal Income

Personal income is the income received by people from all sources: private sector and government wages, salary disbursements, other labor income, self-employment income, rental income, personal dividend income, personal interest income, the Alaska Permanent Fund dividend, and transfer payments. Per capita personal income is the annual total personal income of the residents of an area divided by their resident population. Per capita personal income can be a measure of economic well being because the amount of goods and services that people can purchase is related to their personal income.

Figure 3-10 shows annual per capita personal income for 1969 through 2008 (in 2010 dollars) for residents of the North Slope Borough, compared to that of Alaska residents as a whole, as well as the urban centers of Anchorage and Fairbanks North Star Borough. The North Slope Borough had a higher per capita income than the state or the other communities beginning in 1976 until 1984, when it began to decline. It was below the Anchorage average from 1994 until 2004, when it again led. North Slope residents have generally enjoyed higher level than the statewide average. The statewide average real per capita income, however, has been more stable than that of the North Slope. This is to be expected, as less-diversified regional economies tend to be more sensitive to internal and external economic changes.

While per capita personal income is high, the cost of living in the planning area may be the highest in the Nation. Any discussion of the "economic well-being" of residents of the boroughs should consider that high cost of living offsets the higher income levels. In August 2010, "Alaska Economic Trends" reported the geographic cost differential in 2008 for Barrow was 1.5, where Anchorage was 1.0, or the comparison basis (Fried 2010). These costs do not consider reliance upon subsistence resources, but are indicative of the additional cost incurred to acquire and maintain subsistence equipment, tools, and supplies in addition to other expenditures. Market basket data is not published regularly for North Slope Borough, so it is not included. The most recently published Alaska food cost survey to include Barrow was in 2004.

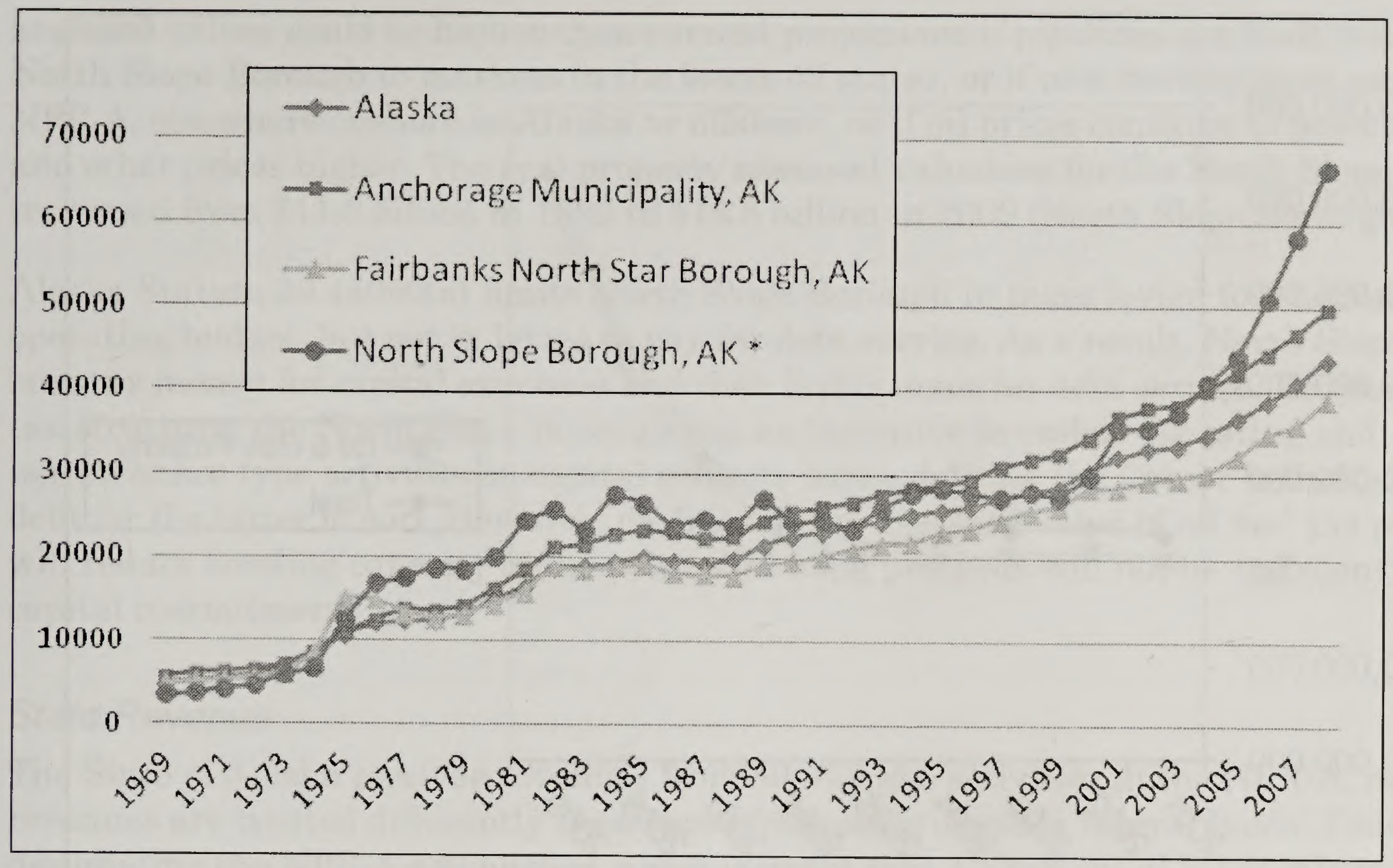

Figure 3-10. Per capita income
(*Combined North Slope Borough 1979-2009 with Bureau of Economic Analysis, Barrow-North Slope Division 1969–1978. Source: U.S. Department of Commerce Bureau of Economic Analysis (2010)

3.4.11.5 Tax Revenues

Local Revenue

Oil and gas property taxes are the primary source of revenue for the North Slope Borough, accounting for 82 percent of general revenues in 2009 (North Slope Borough 2009). Other revenue sources include charges for services, enterprise revenue, state and federal grants, and investment income.

In Alaska, oil and gas property is exempt from local municipal (borough) taxation, but the state levies a 20-mill tax against this property. Each municipality with oil and gas property within its boundaries is reimbursed an amount equal to the taxes that would have been levied on the oil and gas property, up to the 20-mill limit (Alaska Department of Revenue 2010; Alaska Statutes 43.56). The 2009 property tax rate for the North Slope Borough was 18.5 mills (North Slope Borough 2009). Since the 1980s, the North Slope Borough property tax base has consisted mainly of high-value property owned or leased by the oil industry in the Prudhoe Bay area. The oil industry infrastructure has been expanding to the west and now extends to the Alpine development near the NPR-A. In 2001, just over 95 percent of property taxes received by the North Slope Borough came from BP Exploration (Alaska), Inc., Phillips Alaska (now ConocoPhillips), and Alyeska Pipeline Services Company (North Slope Borough 2001). That has now dropped to about 79 percent from the same companies, which continue to be the three largest taxpayers in the North Slope Borough (North Slope Borough 2009). Figure 3-11 shows property tax and oil and gas tax revenues for the North Slope Borough for 2001 through 2009.

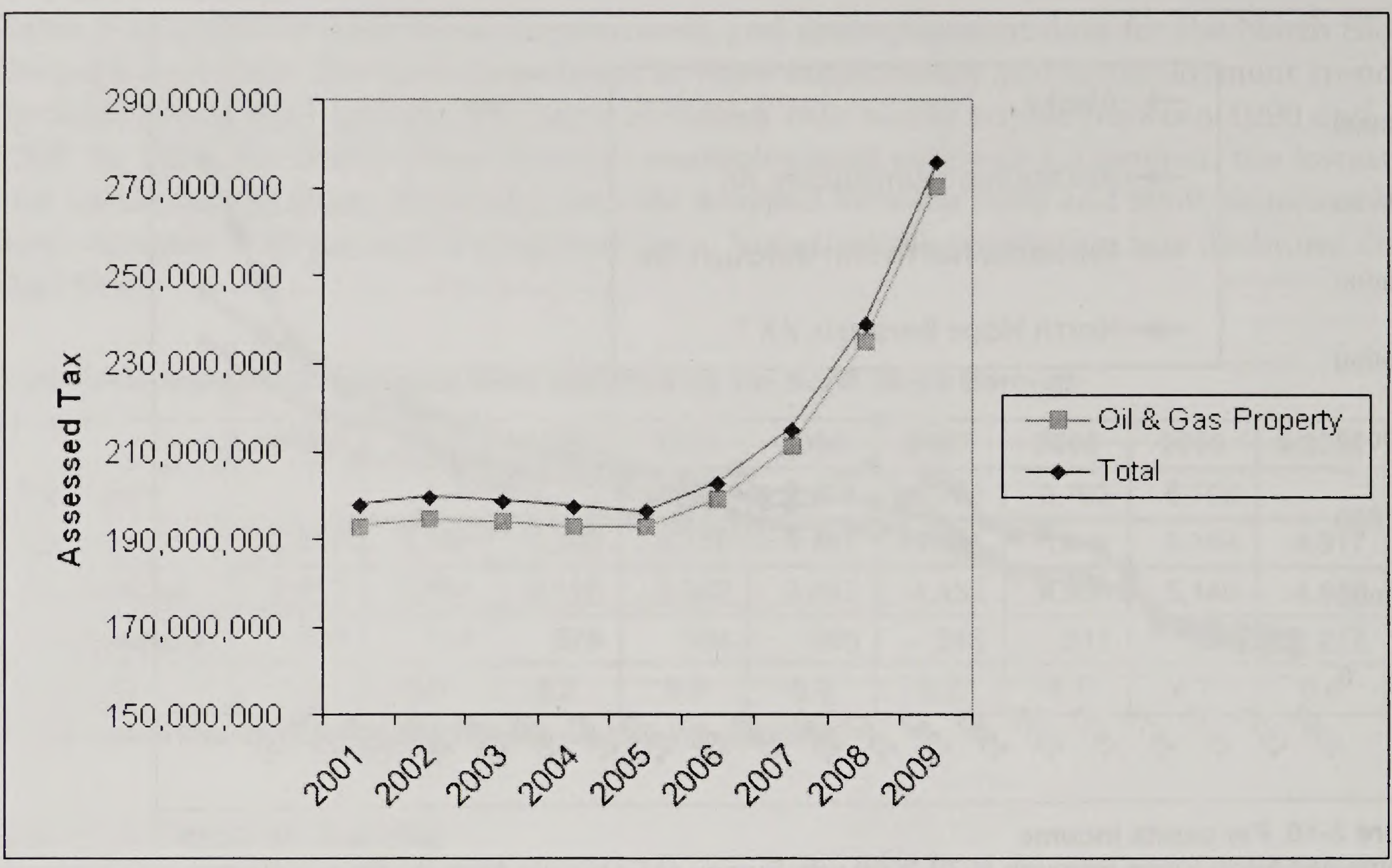

Figure 3-11. Property and oil and gas tax assessments, North Slope Borough 2001–2009
(Source: North Slope Borough 2009)

The petroleum property tax assessment is made at the state level and applies to exploration assets at estimated fair market value, production property at replacement costs new less depreciation based on estimated economic life, and pipeline transportation property at full and true value based on appraisal standards. In general, the exploration assets are valued as a used car would be, by looking at what similar assets in similar condition sell for to knowledgeable buyers. The production and pipeline transportation property assessments are largely based on what it would cost to build at current rates, less an allowance for depreciation. In some cases, the pipeline tax assessment is on the current value of estimated future income. In no case are these based on historic or "book" costs used by the companies in their financial statements. As such, changes to the assessed base come from changes in the quantity of petroleum property; changes in the cost of equipment, materials, or labor used to estimate replacement costs, or in estimates of useful life; and changes in the income certain pipelines are expected to earn. The recent rise in the cost of oil and gas activities worldwide in the mid-2000s has inflated the assessed value of existing petroleum property. This jump has not been forecast by Alaska Department of Revenue to continue, though the longer oil prices remain high, the more the Department includes of the increase in its annual forecasts (Alaska Department of Revenue 2011). In addition, certain changes to indexing methodology were initiated for 2006 and applied for subsequent years that accentuated the rate of increase. The valuation has been and is being litigated for the Alyeska properties.

An issue facing the North Slope Borough if oil prices decline is the potential decrease in revenues due to the decline in assessed value of petroleum-production-related facilities as they depreciate over their useful life, become obsolete, or if the oil properties deflate in value. As assessed values decline, tax revenues, and bonding capacity also decline. Future assessed values could be higher than current projections if pipelines are built from the North Slope Borough to markets in the lower 48 states, or if new development occurs in the NPR-A, elsewhere onshore in Alaska or offshore, or if oil prices continue to push equipment and other prices higher. The real property assessed valuation for the North Slope Borough increased from $11.5 billion in 1992 to $14.8 billion in 2009 (North Slope Borough 2009).

Alaska Statute 29.45090(a) limits North Slope Borough in taxes levied for the municipal operating budget, but not in levies to pay for debt service. As a result, North Slope Borough borrows money for capital expenses and then levies taxes for debt service. Because of the tax structure, the North Slope Borough has an incentive to embed operating and maintenance type activities in capital projects (since debt for the former is limited, while debt for the latter is not). However, declines in the assessed value of oil and gas properties will reduce bonding capacity to the point that bond proceeds will not be sufficient to support capital commitments.

State Revenue

The State of Alaska receives revenues from oil and gas activities in the NPR-A, but these revenues are treated differently than those from state or other federal lands. Federal law designating the NPR-A established a requirement that 50 percent of lease sale revenues, royalties, and other revenues be paid to the State of Alaska (42 USC § 6508), and the other 50 percent be paid to the General Fund of the U.S. Treasury. The 50-percent distribution does not apply to severance, property, and conservation taxes levied by the state. The NPR-A monies paid to the State are to be used for: (1) planning; (2) construction, maintenance, and operation of essential public facilities; and (3) other necessary provision of public service by subdivisions of the state most severely impacted by development of oil and gas leased under the section (USDOI BLM 2003). The State began receiving these monies in 1983.

The State generally receives shared revenues from federal oil and gas leases twice a year and makes these funds available as grants to eligible municipalities in the following state fiscal year. The State places these revenues in the National Petroleum Reserve-Alaska Special Revenue Fund (AS 37.05.530). The Alaska Department of Commerce, Community and Economic Development administers the fund and grants under the National Petroleum Reserve-Alaska Impact Mitigation Program (3 AAC § 150). Funds not issued as grants by the end of each fiscal year are distributed in the following manner: 50 percent to the Permanent Fund, 0.5 percent to the Public School Fund, and 49.5 percent to the General Fund.

Municipalities may apply for grants each year for planning, construction, and maintenance of essential public facilities or for provision of other necessary public services, by demonstrating present or future impact from oil and gas exploration, production, or transportation and by meeting certain eligibility requirements (19 AAC § 50.050).

From 1987 to 1999, nearly $10 million was disbursed by the State of Alaska to fund the National Petroleum Reserve-Alaska Impact Mitigation Program. For FY 2000 through 2010, an additional $119,674,570 was awarded to North Slope communities and the North Slope Borough under the program (Alaska Department of Commerce, Community, and Economic Development 2011). These funds were used to pay administrative salaries; build and maintain facilities in North Slope communities; upgrade equipment; conduct fish, waterfowl, gull, fox, and caribou surveys; monitor subsistence harvest; assess the impacts to fish from hydrocarbons; and provide health care training and education.

Federal Revenue

Lease sales bonus bids have totaled $252,324,921 since 1998, of which $126,162,460 has gone to the Federal Treasury. The total bids by year were:

1999	$104,635,728
2002	$63,811,496
2004	$53,904,491
2006	$13,763,715
2008	$15,409,496
2010	$799,995

These leases have resulted in rental and other fees. Royalties will be earned on any production from leases. As noted elsewhere, a significant number of these leases have expired or been returned to the BLM. In that instance, the BLM can re-offer the leases at future lease sales.

3.4.11.6 The End of Alaska's Oil-Based Economy

The continued decline in oil flowing through the Trans-Alaska Pipeline System is a significant topic for all Alaskans as major tax and other governmental revenues from North Slope oil activities are directly tied to the long-term operation of the pipeline. In 1988 2.1 million barrels per day transited the pipeline, while June 2012 production averaged less than 517,000 barrels per day. As the flow declines, the operating cost allocated to each barrel of oil transiting the system increases. In addition, the declining flow creates additional technical and maintenance issues that require additional capital expenditures or increase overall operating expenses. The pipeline will become uneconomic at some point. When the operation is terminated, all oil resources remaining on the North Slope will be stranded unless other transportation alternatives are created, and oil-related revenues for state and local government will end, as well as the many oil-dependent jobs and businesses mentioned above.

Two significant factors in determining the end date are the volume flowing through the pipeline (throughput) and the price of oil. The more oil, the less expensive it is for each barrel. The higher the price, the more expense that can be absorbed before costs exceed revenue for each barrel. One analysis of the potential Trans-Alaska Pipeline System shutdown and abandonment is found in the Annual Energy Outlook 2012 (US DOE/EIA 2012). That analysis estimates the pipeline could be shut down as early as 2025 in a low oil price scenario. It also cited potential sources of new production from offshore in the Chukchi and Beaufort Seas and onshore in shale and heavy oil deposits. It further mentioned Arctic National Wildlife Refuge resources, where production is currently prohibited. In the reference and high oil price scenarios, where the above mentioned resources are more likely to be developed, the Trans-Alaska Pipeline System appears to remain economic beyond 2035, when reference case Alaska production is 270,000 barrels per day. Other estimates extend the pipeline's life through as long as 2075 (Bailey 2012). Different analyses rely on threshold throughput between 100,000 and 350,000 barrels of oil per day.

Economic diversification would alleviate some of the fiscal and employment challenges that will be created at the end of the Trans-Alaska Pipeline System. For example, operation of a gas pipeline would provide much of the same employment and tax revenue opportunities. In addition, Alaska's Permanent Fund is expected to be used as a buffer until other tax sources can be enacted and collected. Current efforts focus on expanding North Slope production to maximize use of the Trans-Alaska Pipeline System now and in the future.

3.4.12 Public Health

3.4.12.1 Introduction

This section presents an overview of public health in the areas that comprise the affected environment for this IAP/EIS. As described below, the affected environment for public health consists of the eight villages of the North Slope Borough and other villages of the Northwest Arctic Borough whose residents may be affected by the BLM's management of the NPR-A.

The description of health conditions presented in this section is considerably broader than what has, until recently, typically been included in EISs to describe the health of affected populations. This wider scope is driven by two reasons. The first reason relates to changing expectations for what constitutes a sufficient examination of human health within the regulatory process. North Slope residents, the North Slope Borough municipality, the Alaska Inter-Tribal Council, the Iñupiat Community of the Arctic Slope, the Environmental Protection Agency (EPA), and the National Research Council have all advocated strongly for the inclusion of a more systematic and broad-based appraisal of human health concerns in planning processes, and the BLM on the national level is reassessing public health analysis in planning (USDOI 2008, National Research Council 2003). The second reason has to do with data availability. Data has only recently become available that allows the health of the affected environment to be described explicitly; previously, most relevant health indicators were available only at the state level, for all rural Alaska populations, or for all Alaska Natives as a group.

In depicting health conditions in the affected environment, this section begins with a description of biomedical health outcomes—rates of disease, injury, and other indicators of ill health—and follows with a description of "health determinants"—the environmental and social conditions that cause or contribute to biomedical health outcomes. By including both health conditions and health determinants, this section attempts to elucidate the specific pathways through which public health may be affected as well as the outcomes that may result.

The main health conditions that burden the population in the affected environment are the same ones that are seen elsewhere in Alaska and the U.S.: cancer, heart disease, respiratory diseases and intentional and unintentional injury, overweight/obesity and diabetes. Overall, the rates of these illnesses are higher in the affected environment than elsewhere in Alaska and the U.S., although conditions have been improving over the last few decades, and gains continue to be made.

These diseases and health conditions are multifactorial—that is, they arise from a complex combination of factors that affect populations and the individuals within them. These factors include individual behaviors, environmental conditions, institutional supports, and social and economic circumstances. What is important to note in the context of this IAP/EIS is that the factors that are most relevant for disease generation in this population are not necessarily the same as those that apply to populations elsewhere. The unique physical, cultural, and social environment of northern Alaska determines the level of health of the population and of individuals. The health determinants described in this section—such as housing, employment, subsistence participation, and alcohol/drug use—play a critical role in supporting or undermining the health of the population.

3.4.12.2 Data Sources

Although the data presented in this section derive from a large number of sources, there are three sources in particular that are important to note and that have been used extensively throughout this section. The first of these is a report that is currently being prepared by Dr. Jana McAninch on behalf of the North Slope Borough Department of Health and Social Services (North Slope Borough Department of Health and Social Services, McAninch 2010). This report is a comprehensive compilation and analysis of health data pertaining to the communities of the North Slope Borough. The report provides extensive information on health, including analyses by age, sex, location, and trends over time. The information in the report derives from the 2010 North Slope Borough census health module (described below) and also from previously published information about health conditions and outcomes in the North Slope Borough and across Alaska. The report is expected to be published in the spring of 2012, and Dr. McAninch and the North Slope Borough Department of Health and Social Services allowed access to and use of the pre-published data and the narrative interpretation that accompanies it. The report has been cited heavily throughout this section, and wherever there is data presented that is relevant to the North Slope Borough without another reference cited, the information originates from this report.

The second key source of information is the 2010 North Slope Borough Economic Profile and Census (Circumpolar Research Associates 2010). Full results from the census are expected to be released in early 2012; we obtained access to the census results via Dr. McAninch's report, and with the permission and assistance of the North Slope Borough Department of Health and Social Services. The census results are also cited extensively in this section, particularly in the tables. Because the methodology of a census or survey influences the results, some relevant information about the census has been provided by Circumpolar Research Associates, the organization that developed and administered the census:

> The 2010 North Slope Borough Census is the fourth in a series of local household surveys undertaken by the North Slope Borough to enumerate the local population for each community and examine topics such as employment, subsistence participation, income, housing characteristics, Inupiaq language proficiency, and residents' attitudes on a variety of topics. Previous censuses were conducted in 1992, 1998, and 2003, although the instrument and survey design have been modified somewhat over that period.
>
> The 2010 census, funded and coordinated by the North Slope Borough, was contracted out to Circumpolar Research Associates (CRA), who developed the instrument, selected and trained the census enumerators (primarily graduate students), entered and are currently completing the data analysis, using the SPSS

software program. This year, a new health module was added to the questionnaire upon request by the North Slope Borough Health Department, as part of their larger Baseline Community Health Analysis project. Jana McAninch, MD, MPH, the Health Department's contractor for this project, collaborated with CRA and the Borough to develop the health module and analyze and write up the health sections for the 2010 Census report and for inclusion in the Baseline Community Health Analysis, both due to be published this spring.

After mapping all the occupied structures in each community the 2010 North Slope Borough census takers conducted face-to-face interviews, attempting to reach every household in each North Slope Borough community. Sampling proportions ranged from 65% in Barrow (i.e., 943 households interviewed out of a total of 1449) to nearly 90% in some of the smaller communities. The total potential households for each community were determined by analyzing utility (primarily electricity) hookup data provided by the Borough. Given such high sampling fractions and absent any reasonable expectation of sampling bias this survey provides an extremely representative picture of the population. Standard errors of the proportion range from 1.9% to 7.5% depending on the community. For the North Slope Borough as a whole with 1,604 households interviewed out of total of 2,271 the standard error is 1.4%.

For each household, an attempt was made to interview the adult who identified themselves as the "household head," a household member who was available and likely to have the greatest familiarity with household economics, health of household members, level of subsistence participation, etc. The respondents, or "household heads" were asked all the questions as they pertained to themselves and then a smaller subset of questions as they pertained to all other household members, acting as a proxy. Household heads participating in the census were 48% male and 52% female.

Household heads participating in the census were 69% Inupiat, 19% Caucasian, and 12% of other ethnic groups (Circumpolar Research Associates 2011).

The third significant source of information is the Alaska Native Epidemiology Center's 2008 Regional Health Profile of the communities in the Maniilaq service area (Alaska Native EpiCenter 2008). The Maniilaq Association provides health, tribal, and social services to all Northwest Arctic Borough communities included in the study area (see section 3.4.12.3) as well as to Point Hope (which is also part of the North Slope Borough). Information about the Maniilaq service area can therefore be used as a proxy for health information about the Northwest Arctic Borough.

Two last points are important to note about the data presented in this section. First, the population of the affected communities is relatively small, and when de-aggregated into individual villages, it is smaller still. Small populations mean small numbers of cases on an annual basis, with potentially large fluctuations from year to year. For this reason, rates of uncommon diseases or health conditions in the affected environment must be interpreted with caution.

Second, the tables often contain data that has been obtained from different sources. In this case, the original questions or methods used to obtain the data may vary between sources, and thus comparisons between these data sets should be made cautiously.

3.4.12.3 Study Area and Population Demographics

The affected environment for the Public Health sections of this plan comprise the villages whose residents may be affected by social or environmental changes that result from BLM's management of NPR-A. This includes the eight villages of the North Slope Borough (Anaktuvuk Pass, Atqasuk, Barrow, Kaktovik, Nuiqsut, Point Hope, Point Lay and Wainwright) and most villages of the Northwest Arctic Borough (Ambler, Kiana, Noatak, Shungnak, and to a lesser extent, Kotzebue, Kobuk, Selawik and Noorvik).

The population of the villages in the affected environment is described in Table 3-44. There are two larger communities, Barrow and Kotzebue, but the majority of villages are small, with populations fewer than 1,000 residents. The majority of residents in all communities (roughly 90 percent except in Barrow and Kotzebue) are Iñupiat or Native Alaskan. The population is very young, with the median age between 20 and 25 years old and children comprising 34 percent of the population in the North Slope Borough. This age structure influences the health conditions likely to be observed in the North Slope Borough, since younger populations are more likely to experience higher rates of infectious diseases, injuries, and some mental illnesses. Older populations, in contrast, tend to exhibit higher rates of chronic disease such as heart disease, diabetes, arthritis, and cancer.

Table 3-44. Population demographics in affected environment villages

Village	Population size	Percent Iñupiat/Native Alaskan	Median age	Proportion of residents over the age of 65	Proportion of residents under the age of 18
North Slope Borough Villages					
Anaktuvuk Pass	287	88%	25.7	4%	36%
Atqasuk	201	93%	26.3	6%	39%
Barrow	4,119	65%	28.8	5%	32%
Kaktovik	286	86%	32.1	10%	30%
Nuiqsut	424	89%	23.8	6%	31%
Point Hope	713	93%	21.8	8%	37%
Point Lay	234	89%	20.8	5%	40%
Wainwright	551	95%	24.5	8%	35%
Northwest Arctic Borough Villages					
Ambler	261	87%	21.8		
Kiana	374	93%	22.4	n/a	n/a
Kobuk	122	89%	17.4	n/a	n/a
Kotzebue	3,150	71%	25.9	n/a	n/a
Noatak	486	93%	22.0	n/a	n/a
Noorvik	628	90%	21.3	n/a	n/a
Selawik	849	95%	18.9	n/a	n/a
Shungnak	270	95%	18.8	n/a	n/a

Source: CCED (2010); Alaska Community Database Community Information Summaries; Advameg, Inc. (2009). Note that these data are derived from the 2000 census.

The focus of the analysis of impacts in Chapter 4 will consider the entire affected environment to the degree to which effects are predicted for each community. In this chapter, current health conditions are described more intensively for the eight villages of the North Slope Borough than for communities in the Northwest Arctic Borough. This is primarily because more specific and fine-grained data about health conditions exists for the North Slope Borough villages, as described in section 3.4.12.2, "Data Sources." However, the Northwest Arctic Borough communities share many common features with the North Slope Borough villages, including many lifestyle, environmental, social, economic and cultural conditions that determine health outcomes, such as reliance on subsistence resources including the Western Arctic Caribou Herd, remote location, small population comprised mainly of Iñupiat people, limited infrastructure, housing type and availability and limited economic opportunities. In addition, many of the health outcome indicators described in this chapter indicate that biophysical health outcome measures are likely to be similar for the populations in North Slope Borough and Northwest Arctic Borough villages. As a result, the impact pathways between proposed leasing alternatives and human health outcomes are likely to be similar for North Slope Borough villages and Northwest Arctic Borough villages, as are the effects that will be experienced. The additional fine-grain of detail available for North Slope Borough villages therefore provides an extra source of information that will help in the analysis of impacts; but the lack of this same level of detail for Northwest Arctic Borough villages will not preclude a full assessment of impacts for those locations.

3.4.12.4 Biomedical Health Outcomes

This section presents an overview of biomedical health outcomes and diseases experienced by the population in the affected environment. Biomedical health refers to illnesses, diseases, injuries, and other health states experienced by individuals.

General Health Indicators

General health indicators provide a picture of the overall health status of the population. The health indicators presented in this section reflect important measures of population health and wellness that can be compared across time and across different regions to understand how the health of one population compares with the health of others.

As can be seen from the data in Table 3-45, residents of the North Slope Borough report lower rates of excellent/very good health and higher rates of fair/poor health than residents of Alaska as a whole, both for children and for adults, with considerable diversity among the different North Slope Borough villages. Self-rated health is one of the strongest, most consistent predictors of illness, premature death, health care utilization, and hospitalization (Idler and Benyamini 1997). The observation that North Slope Borough residents experience poorer overall health than other Alaskan residents is supported by data that show the North Slope Borough ranking 15th out of 23 Alaskan census areas for overall health outcomes and 17th out of 23 census areas for health factors, based on a combination of standard health indicators (Mobilizing Action Toward Community Health 2010a). The rankings for health outcomes and health factors for the Northwest Arctic Borough are 19th and 20th, respectively.

Table 3-45. General health indicators in the North Slope Borough (percent)

Reported health status	Anaktuvuk Pass	Atqasuk	Barrow	Kaktovik	Nuiqsut	Point Hope	Point Lay	Wainwright	All North Slope Borough	All Alaska
Adults										
"Very good" or "excellent" general health	32	21	53	38	39	36	52	35	46	56[a]
"Fair" to "Poor" general health	4	34	13	19	22	21	10	21	16	14[a]
Children										
"Very good" or "excellent" general health	41	38	68	66	55	66	70	54%	63	89[b]
"Fair" to "Poor" general health	4	9	4	10	16	7	1	7	6	

Source: Circumpolar Research Associates (2010), North Slope Borough Census, with the exception of:
a. Centers for Disease Control and Prevention (2008), Behavioral Risk Factor Surveillance System; and
b. Child and Adolescent Health Measurement Initiative (2007), National Survey of Children's Health.

Life expectancy and mortality are also commonly used to evaluate and compare the health of populations. Between 1999 and 2008, the life expectancy at birth for a resident of the North Slope Borough was estimated as 71.9 years, approximately 4 years shorter than for Alaskans overall (75.6 years), although the estimate was similar to that for Alaska Natives statewide (Alaska Bureau of Vital Statistics 2008). However, rates of adult and infant mortality have declined in the North Slope Borough over the past three decades, representing overall health improvements in the area.

Since the early 1990s, the leading causes of death in the North Slope Borough (Table 3-46) have been fairly constant. Cancer is the leading cause of death in both the North Slope Borough and across Alaska, followed by heart disease and accidents/injuries. The leading causes of self-reported health problems among Iñupiat adults (over age 16) participating in a 2004 survey were high blood pressure (reported in 29 percent of respondents), arthritis/rheumatism (21 percent), asthma (21 percent), stomach problems or intestinal ulcers (15 percent), chronic bronchitis, emphysema, or shortness of breath (12 percent), and heart problems (9 percent). The leading causes of death in the Maniilaq service area are similar, with cancer as the primary cause of death, and heart disease, unintentional injuries and suicide also ranking in the top four.

Table 3-46. Leading causes of death in the North Slope Borough and Maniilaq service area

	North Slope Borough			Maniilaq Service Area			Alaska	
	Rank	No. of deaths	Rate (age-adjusted)	Rank	No. of deaths	% of deaths	Rank	Rate (age-adjusted)
Cancer	1	29	272.9	1	39	17.8%	1	181.3
Heart Disease	2	26	274.8	4	28	12.8%	2	154.8
Unintentional injuries	3	17	125.2	2	38	17.4%	3	54.8
Chronic Lower Respiratory Diseases	4	10	144.3	7	8*	3.7%	5	42.5
Suicide	5	10	53.3	3	30	13.7%	6	22.7

Sources: Alaska Bureau of Vital Statistics (2008) and Alaska Native EpiCenter (2008).

Note: Rates are per 100,000 persons, age-adjusted to U.S. year 2000 standard population. Definition for chronic lower respiratory disease for Maniilaq service area includes only chronic obstructive pulmonary disease.

Chronic Diseases

Important chronic diseases in the affected environment include chronic respiratory disease, cancer, and cardiovascular conditions (Table 3-47).

Table 3-47. Chronic disease in the North Slope Borough

	All North Slope Borough	All Alaska
Proportion of adults who report a health professional diagnosis of:		
High blood Pressure	20%	26%[a]
Heart disease	5%	3%[b]
Thyroid problems	4%	9% (U.S.)[c]
In the past 12 months, percent who experienced:		
Chronic breathing problems (adults)	8%	10%[d]
Chronic breathing problems (children under 18)	5%	5-6%[d, e]
Daily pain or arthritis that limits activities or requires prescription pain medicine	21%	

Source: Circumpolar Research Associates (2010), North Slope Borough Census with the exception of:

a Centers for Disease Control and Prevention (2009), Behavioral Risk Factor Surveillance System;

b Centers for Disease Control and Prevention (2008), Behavioral Risk Factor Surveillance System (Heart disease: Alaska estimate includes only diagnoses of angina, heart attack, coronary heart disease. North Slope Borough estimate may include other types of heart disease such as congestive heart failure, heart rhythm problems, or valvular heart disease);

c Melzler (2010);

d Based on Centers for Disease Control and Prevention (2004), Behavioral Risk Factor Surveillance System; Gessner and Utermohle (2006), Asthma in Alaska: 2006 Report; Child and Adolescent Health Measurement Initiative (2007), National Survey of Children's Health; and

e Child and Adolescent Health Measurement Initiative (2007), National Survey of Children's Health.

Chronic lower respiratory disease is one of the most frequently cited health concerns among community members in the North Slope Borough and has been the fifth leading cause of death in the Borough for most years since 1990. Mortality rates from chronic lower respiratory disease in the North Slope Borough remain almost twice statewide rates and nearly three times the mortality rate for the U.S. (130 per 100,000 residents compared with 45 per 100,000) (Day et al. 2006). Between 1999 and 2007, 10 percent of North Slope Borough residents reported having asthma (McAninch 2010). This value is slightly lower than state or national rates; however, the difference is not statistically significant. Asthma rates are fairly evenly distributed amongst Alaska residents with no differences seen between urban and rural or Native and non-Native populations (McAninch 2010). A number of environmental factors are known to trigger or exacerbate asthma and chronic lower respiratory disease symptoms, including exposure to tobacco smoke, exhaust from heating sources and nearby vehicles, and outdoor and indoor air quality. Arctic residents are particularly vulnerable to indoor air pollution due to tightly sealed houses and poor ventilation, as well as prolonged time spent indoors (Gordian 2004). High rates of smoking in the North Slope Borough may be a primary cause of high respiratory disease rates. However, it is not possible to estimate the possible contribution of environmental factors to chronic respiratory disease in the area (National Research Council 2003).

Cancer is the leading cause of death across Alaska, among Alaska Natives, and in the North Slope Borough, and it is understandably a major community health concern in many areas. Between 1996 and 2007 there were a total of 225 cases of cancer reported in the North Slope Borough (McAninch 2010). This corresponds to an age-adjusted annual incidence rate of 491.7 cancers per 100,000 population, compared with 482.9 for all Alaska and 468.5 for the U.S. Because the numbers of cancers in the North Slope Borough are small, there is the potential for a large margin of error, and a great deal of year-to-year variation, and therefore the differences between the North Slope Borough and Alaska/the U.S. are not statistically significant. Within the Maniilaq service area, cancer deaths increased 36 percent between the 1979–1983 and 1999–2003 time periods, from 255 to 348 deaths per 100,000 population (Alaska Native EpiCenter 2008). The U.S. cancer death rate for that same period decreased 4 percent; however, as with the North Slope Borough, small population numbers in the Northwest Arctic Borough may lead to a large margin of error.

The most common cancers in the North Slope Borough are lung/bronchus, colon/rectum, prostate, and breast. These are also the most common four cancers across the state and the U.S. Age-adjusted rates of lung and colorectal cancers in the North Slope Borough for the years 1996–2007 are approximately double the national rates; however, rates of prostate and breast cancers are close to half the national rate. For other cancer sites, the number of cases across the North Slope Borough is so small that it is difficult to compare the rates with those in other jurisdictions. Within the Maniilaq service area, the top four cancers are colon/rectum, lung, breast and kidney, with rates of prostate cancer approximately half of statewide rates for all Alaska Natives (Alaska Native EpiCenter 2008).

Like people in many other places, Alaska residents are concerned about environmental contamination as a possible contributor to cancers, there is no easy way to determine whether or to what extent environmental factors play a role. What is known is that tobacco smoking is currently a large contributor to cancers among Alaska Natives and circumpolar Inuit, and directly contributes to high rates of lung cancer and overall cancer mortality.

Cardiovascular disease has been a leading cause of death in the U.S. for many decades, and is currently the second leading cause of death in Alaska. The amount, or prevalence, of cardiovascular disease has been increasing in the North Slope Borough, but death from cardiovascular disease has been decreasing, which has frequently been attributed to improvements in medical intervention. Smoking, excess weight, and diabetes, all of which have been increasing in the North Slope Borough, are risk factors for cardiovascular disease.

Diabetes is another chronic disease of great importance in the North Slope Borough, and is discussed in the section "Nutritional Outcomes" on page 496 due to its association with dietary factors.

Infectious Diseases

Infectious diseases disproportionately impact Alaska Natives, illustrated by higher incidence rates and higher rates of hospitalization than non-Natives (Holman et al. 2001). The main infectious disease categories likely to be impacted by development activities in the NPR-A are sexually transmitted diseases (STDs) and infectious respiratory diseases, including tuberculosis (TB).

The reported rates of the sexually transmitted diseases chlamydia, gonorrhea and hepatitis C have increased since mandatory reporting began in 1996. Gonorrhea increased dramatically in 2007, the most recent year for which data is available, with 59 new cases reported in the North Slope Borough, compared with between 6 and 30 cases per year for the 6 years prior (Cecere 2008). For all three of these infections, incidence rates are substantially higher in the North Slope Borough than the Alaska average; however, the trend of increasing incidence parallels similar trends seen in the state and across the nation (McAninch 2010, National Coalition of STD Directors 2005). Higher rates prevail among all Alaska Natives compared with non-Natives; sexually transmitted disease rates between two and six times higher have been reported for HIV, chlamydia, gonorrhea, syphilis and hepatitis for Alaska Natives statewide, compared to non-Native Alaskans (National Coalition of STD Directors 2005). In the Maniilaq service area, rates of sexually transmitted diseases are particularly high; with chlamydia rates of 2,823 per 100,000 population, which is four times higher than all Alaskans and eight times higher than national rates, and gonorrhea rates of 432 per 100,000, which is more than four times higher than all Alaskans (Alaska Native EpiCenter 2008).

Infectious respiratory diseases are common, and include lower respiratory tract infections, such as pneumonia and respiratory syncytial virus (RSV), and upper respiratory tract infections, such as colds, flus, and the common complication of ear infections (Table 3-48). Upper respiratory tract infections account for almost one-third of visits with assessments in the North Slope Borough (Golnick 2009) and contribute to days missed at work/school, increased health care costs, and can sometimes lead to more serious health problems. Lower respiratory tract infections can be very serious; in 2006–2007, an outbreak of respiratory syncytial virus occurred on the North Slope, resulting in the hospitalization of 53 infants and young children in Barrow. Twenty-eight children required transport to Anchorage for intensive care (McAninch 2010).

Table 3-48. Ear infections in the North Slope Borough

In the past 12 months, percent who experienced frequent (3 or more) or chronic ear infections	All North Slope Borough	All Alaska
Adults	4	
Children under 18	19	5[a]

Source: Circumpolar Research Associates (2010), North Slope Borough Census with the exception of:
a Child and Adolescent Health Measurement Initiative (2007), National Survey of Children's Health.

Tuberculosis is another infectious disease of great public importance, particularly given the devastation wrought by TB in rural Alaska half a century ago. There has been an average of less than one new case a year reported in the North Slope Borough over the past 25 years; however, the state of Alaska is hoping to reduce this rate even further (Pearson 2002).

A disease of concern among Alaska natives is *Helicobacter pylori* infection. *H. pylori* is commonly found in conditions with inadequate sanitation and causes chronic inflammation of the stomach and small intestine, and may be associated in Alaska Natives with iron deficiency and anemia among children (DiGirolamo et al. 2007, Baggett et al. 2006) and possibly with stomach cancer among adults. Unusually high rates of *H. pylori* have been found among Alaska natives. Based on a sample of approximately 2,000 stored blood samples taken between 1980–1986, rates of H. pylori infection were estimated to be about 75 percent among Alaska Natives (Parkinson 2000). While the reasons for these high rates are not clear, the strain of the bacteria is unusually resistant to treatment (Centers for Disease Control 2011).

Few parasitic diseases have been reported in the literature as presenting a significant medical problem in Alaska. The parasitic diseases most likely to cause problems in humans in the area are giardia, brucellosis, and trichinella. However, concern has been raised that changing of the landscape, water supply and subsistence food practices (including food harvesting, preparation and storage) caused by climate change, development activities, or other causes, could cause an increase in the rates of parasitic diseases experienced by humans (Brubaker et al. 2011).

Nutritional Outcomes

Diet and nutrition play an important part in health. Healthy diets prevent disease and are important to maintain at community and individual levels. Native populations in Alaska and elsewhere have experienced marked changes in disease patterns stemming from the rapid transition from a healthy subsistence diet to a more Western diet and lifestyle, resulting in increases in obesity, diabetes, and other chronic diseases (Kuhnlein and Receveur 1996).

Overweight, obesity, and diabetes present significant health burdens to North Slope Borough (Parnell et al. 2008). This constellation of disorders is linked with increased risk of developing a number of other chronic health problems, including high blood pressure, heart disease, arthritis, certain cancers, and some types of respiratory problems.

As shown in Table 3-49, in 2006–2008 the North Slope Borough had substantially higher estimated adult obesity rates than the Alaska average, with almost two-thirds of residents self-reporting as overweight or obese. One-half of children in the North Slope Borough are overweight or obese, making rates of childhood obesity in the North Slope Borough well above the state average for Alaska. Between 1990 and 2005, the prevalence of diabetes in the Barrow service unit increased by roughly 130 percent, or by nearly three times the overall U.S. rate (McAninch 2010). In the Maniilaq service area, 25.2 percent of residents were classified as overweight, with a further 25.4 percent classified as obese. Across all of Alaska, rates of overweight individuals are similar in Natives compared to non-Natives, although rates of obesity are significantly higher in Alaska Natives (38.1 percent vs. 26.1 percent) (Parnell et al. 2008).

Table 3-49. Nutritional outcomes (percent of adults by location)

Indicator	Anaktuvuk Pass	Atqasuk	Barrow	Kaktovik	Nuiqsut	Point Hope	Point Lay	Wainwright	All North Slope Borough	Maniilaq Service Area	All Alaska
Diabetes									6	3.9[a]	6[b]
Overweight (BMI 25-29.9 kg/m^2, based on self-reported height and weight)									33	25.2[a]	37[b]
Obese (BMI 30 kg/m^2 or higher, based on self-reported height and weight)									39	25.4[a]	28[b]
High cholesterol									13		35[b]
Percent of households that found it difficult to get the foods they needed to eat healthy meals in the past year	57	59	28	40	38	36	51	46	35		
Percent with household members who at times did not have enough to eat	40	20	14	19	25	24	22	30	19		

Source: Circumpolar Research Associates (2010), North Slope Borough Census with the exception of:
a Alaska Native EpiCenter 2008. Note that rates for Maniilaq service area is among all population, not just adults; and
b Centers for Disease Control and Prevention (2009), Behavioral Risk Factor Surveillance System.

Rates of diabetes among adults in the North Slope Borough vary substantially depending on the data source. The North Slope Borough census data show rates very similar to those of adults across Alaska (Table 3-50), and this similarity has also been found in the Behavioral Risk Factor Surveillance Survey telephone survey data. However, the Alaska Native Medical Center's diabetes program that maintains a statewide diabetes registry found the age-adjusted diabetes prevalence for the Barrow service area to be the second lowest in the state, estimated at only 2.8 percent. As has been happening across the country and state, rates of diabetes have risen rapidly in the North Slope Borough over the last several decades. Between 1985 and 2005, the crude prevalence of diabetes seen in the

Barrow service unit more than doubled, from approximately 7 to approximately 16 cases per 1,000 users per year. In the Maniilaq service area, 3.9 percent of the population (all ages) was reported to have diabetes as of 2006. The 2006 rate represents an increase of 125 percent over 1990 rates (Alaska Native EpiCenter 2008).

Table 3-50. Nutritional outcomes across Alaska

Indicator	All Alaska	American Indian /Alaska Native	All Rural Alaska
Proportion of Alaskan adults with pre-diabetes or borderline diabetes	8.1% (95% confidence interval: 7.0% - 9.4%)	10.1% (95% confidence interval: 7.4% - 13.6%)	6.5% (95% confidence interval: 4.9% - 8.6%)
Proportion of Alaskan adults with non-gestational diabetes	6.7% (95% confidence interval: 5.7% - 7.8%)	8.2% (95% confidence interval: 5.7% - 11.6%)	5.7% (95% confidence interval: 3.9% - 8.1%)

Source: Parnell et al. (2008), Health Risks in Alaska among Adults: Alaska Behavioral Risk Factor Survey 2008

Food insecurity and a change away from subsistence food sources may contribute to the risk for obesity and the associated chronic illness for residents in the North Slope Borough. Food insecurity refers to an inability to secure sufficient healthy food for a family. Those facing food insecurity often turn to high-calorie food with low nutrient value (Alaska Division of Public Health 2008b, Bersamin et al. 2006, Bersamin et al. 2007, Bersamin et al. 2008). This is often because processed or packaged foods are cheaper or more readily available in rural/remote areas than fruits and vegetables because of their longer shelf life. This is discussed further in the section "Subsistence Participation and Diet" on page 504.

Injuries

Injuries are an important health outcome that can lead to lost worker productivity and income, increased health care costs over the short and long term, disability, and even death (McAninch 2010). Injuries not only impact those involved; caregivers and family members can also experience mental anguish and decreased quality of life. In Alaska, injuries account for a large proportion of premature death, particularly in children and within Native populations (McAninch 2010).

In the North Slope Borough, injury—which includes unintentional injuries, suicide, assault, and homicide—is the second leading cause of death as well as the second leading reason for hospitalization, and disproportionately impacts younger populations (National Research Council 2003). The Alaska Trauma Registry reports that the North Slope Borough has the highest rates of hospitalizations due to injuries in the state (141 per 100,000 residents), over double the state average (National Research Council 2003). Death due to injury also disproportionately affects Alaska Natives compared to other population groups. The rate of mortality for unintentional injury is approximately 3.5 times higher for Alaska Natives than U.S. Caucasians (Day et al. 2006).

Table 3-51 lists the leading causes of injury hospitalizations for the North Slope Borough over a 5-year period. Accidental falls account for the greatest number of hospitalizations, followed by motor vehicle accidents (for on- and off-road vehicles, including snowmachines and all-terrain vehicles) and intentional violence. High risk-taking behavior, much of which is associated with alcohol consumption, is thought to contribute to many injuries. The unique social and physical environments in Alaska's north also contribute to high injury rates in this area. The number and severity of injuries may be substantially underreported, due to a lack of hospital facilities in the villages and limited hospital beds in Barrow, which results in many injuries being treated as outpatient visits rather than hospitalizations.

Table 3-51. Injury hospitalizations in the North Slope Borough and Maniilaq service area

Injury	North Slope Borough: number of hospitalizations 2002-2006	Maniilaq: number of hospitalizations 2000-2005
Accidental falls	56	163 (23.5%)
Off-road vehicle (four-wheelers)	23	59 (7.9%)
Suicide and self-inflicted injury	20	176 (23.5%)
Injury purposefully inflicted by other persons	16	107 (14.3%)
Snow machine accidents	6	83 (11.1%)
Motor vehicle accidents	6	--

Source: Alaska Trauma Registry and Alaska Native EpiCenter (2008a).

Within the Maniilaq service area, accidents and injuries represented third leading cause of hospital discharges, hospital inpatient days and hospital outpatient visits (Alaska Native EpiCenter 2008). As described in Table 3-51, suicide attempts and falls were the most common causes of injury hospitalizations, accounting for almost half of injury hospitalizations. Assaults and snowmachine/all-terrain vehicle accidents were also top causes (Alaska Native EpiCenter 2008).

Social Pathologies and Mental Health

Social and psychological problems, including alcohol and drug problems, unintentional and intentional injury and suicide (a high percentage of which are associated with alcohol use), depression, anxiety, and assault and domestic violence, are now highly prevalent on the North Slope (as they are in many rural Alaska Native and Arctic Inuit villages in Canada and Greenland) and cause a disproportionate burden of suffering and mortality for these communities (USDOI 2008). These problems rarely occur in isolation, but usually arise in the context of specific sociocultural and physical environments that shape human behavior. Research in circumpolar Inuit societies suggests that social pathology and related health problems, which are common across the Arctic, relate directly to the rapid socio-cultural changes that have occurred over the same time period (Bjerregaard et al. 2005, Curtis et al. 2005, Goldsmith et al. 2004).

Alcohol and drug misuse, which usually comprise a significant component of and contributor to social pathologies, are discussed in detail in the section "Alcohol and Drug Misuse" on page 509. As shown in Table 3-52, a large proportion of North Slope Borough residents feel that their families and communities have been hurt by drug or alcohol use.

Table 3-52. Social pathologies in the North Slope Borough

Social Pathologies	Percentage
In the past 12 months, felt a household member had been hurt by drugs or alcohol[1]	30%
In the past 12 months, often felt the health of their community had been hurt by drugs or alcohol	57%
In the past 12 months, sometimes felt the health of their community had been hurt by drugs or alcohol	35%

Source: Circumpolar Research Associates (2010), North Slope Borough Census

1 Includes all head of households (survey respondents)

Table 3-53. Mental health (depression) across Alaska

Indicator	All Alaska	American Indian/Alaska Native	All Rural Alaska
Proportion of Alaskan adults with current moderate-to-severe depression	7.6% (95% confidence interval: 5.9% - 9.7%)	9% (95% confidence interval: 6% - 15%)	8% (95% confidence interval: 5% - 11%)

Source: Parnell et al. (2008), Health Risks in Alaska Among Adults: Alaska Behavioral Risk Factor Survey 2008.

In 2006–2008, suicide was the fourth leading cause of death in the North Slope Borough. Since 1990, age-adjusted suicide mortality rates in the North Slope Borough have averaged twice the statewide average and four times the national average, with a rate of 52.9 suicides per 100,000 population between 2004 and 2006 (Alaska Injury Prevention Center 2006). In the 2000–2005 time period, the Maniilaq service area had the highest rate of suicide in the state, and suicide attempts accounted for almost one-fourth of all injury hospitalizations (Alaska Native EpiCenter 2008). For both areas, there may be a great deal of rate instability due to relatively small numbers in those populations.

Alaska Natives are at particular risk of suicide, comprising 39 percent of all suicides in the state (Alaska Injury Prevention Center et al. 2006). This trend is also apparent in youth; 13.8 percent of Alaska Native high school students reported having had attempted suicide in the previous 12 months compared to 6.4 percent of white high school students (McAninch 2010). Overall, true suicide rates are thought to be higher than the rates reported, as a significant percentage of accidental injury deaths are thought to be due to suicidal risk-taking behavior (McAninch 2010).

Mental health is a critical part of overall health. The Survey of Living Conditions in the Arctic estimated that 6 percent of adult Iñupiat in the North Slope Borough were likely suffering from depression (Poppel et al. 2007). This figure appears similar to statewide estimates for Alaskan adults, although the figures are not directly comparable due to differences in survey methodology. However, underreporting of mental health problems is common, especially in some Native populations (McAninch 2010). Other societal factors, such as high rates of domestic violence and suicide mentioned above as well as high rates of child maltreatment indicate that mental health status in the North Slope Borough might be worse than what these statistics imply (McAninch 2010). In both the North Slope Borough and in other populations, depression and anxiety are often higher among youth than adults.

Rates of assault and domestic and sexual violence in Alaska are consistently among the highest in the nation. The North Slope Borough is no exception to this trend. The U.S. Department of Health and Social Services reported that between 2000 and 2003 rates of rape and assault in the North Slope Borough were 8 to 15 times greater than the national average (National Research Council 2003). During 2004–2006, 29 percent of adult respondents reported having been hit, hurt, or threatened by an intimate partner sometime in their lifetime; the state average is 22 percent (Behavioral Risk Factor Surveillance Survey 2006). Across Alaska, Natives suffer disproportionately higher rates of domestic violence than non-Native Alaskans (Rivera 2010).

Maternal and Child Health

Indicators of maternal and child health provide insight into overall health status and social wellbeing at a societal level, since they are highly sensitive to changing social and environmental conditions. The infant mortality rate for the North Slope Borough was reported as 9.2 per 1,000 live births between 1998 and 2007. Although this rate has been steadily declining in the North Slope Borough since 1977, this rate is still higher than the state rate of approximately 6.5 deaths per 1,000 live births and is above the state target of 4.5 per 1,000 live births (Pearson 2002). However, the North Slope Borough has the lowest 10-year average infant mortality rate of all the northern, southwest, and interior rural Alaskan regions (Alaska Bureau of Vital Statistics 2007). In the Maniilaq service area, there was a 63 percent decline in infant mortality between 1980 and 2003, from almost 30 to 10.2 per 1,000 live births (Alaska Native EpiCenter 2008).

Child mortality among all Alaska Natives is higher than among Alaska non-Natives, and this health disparity has persisted over many years. Between 2003 and 2005, child mortality among children ages 1 to 4 was 103.4 per 100,000 population in Alaska Native children vs. 23.7 per 100,000 for non-Native children (Schoellhorn et al. 2008). The proportion of deaths due to unintentional injuries among all Alaska Natives increases from young children to adolescents to teenagers. While homicide is the second leading cause of death in children aged 0 to 9, suicide becomes the second leading cause of death for youth and teens (Schoellhorn et al. 2008).

Mortality is not the only indicator of child health. Of particular relevance to Alaska Natives is tooth decay, a health issue that is predominant in Native populations across the country. Rates of untreated tooth decay in Alaska Native and American Indian children have been two to five times the rates for non-Native children (Indian Health Service 1999, Riedy 2010), and high intakes of sugar-sweetened beverages appear to be a causative factor. As discussed in the section on “Nutritional Outcomes”, diabetes and obesity also greatly impact youth of the North Slope Borough and represent serious public health concerns.

Health Disparities

Although population-level health data are usually presented in a way that aggregates individual experience and shows the "average" experience of health, it is important to note that significant health disparities exist among individuals, and also among subsets of the population. While some people and some groups will always be healthier than others, systematic health disparities—also termed health inequities—generally arise along predictable lines. Groups that experience some areas of disadvantage, such as economic disadvantage, environmental injustice, or social dysfunction, are usually those that experience health disparities.

In Alaska, these health inequities can generally be found when looking at differences between rural and urban populations, and among racial and socioeconomic groups. Alaska Natives, people living in rural areas, and the poor are generally worse off in terms of almost all measurable health outcomes (Alaska Native EpiCenter 2008, 2009).

Examples of health disparities between Alaska Natives and non-Natives can be seen in a large number of health outcome indicators. In the year 2000, the life expectancy for Alaska Natives was 69.5 years, lagging the life expectancy of 76.5 years for the general U.S. population (Parkinson 2006). Rates of unintentional injury are higher in Natives, as is cancer mortality, social pathologies (including suicide, homicide, family and intimate partner violence), smoking-related illness such as lung cancer, and chronic lower respiratory disease (Day et al. 2006, Lanier et al. 2006). Indicators of maternal and child health are also worse for this group.

Disparities are neither fixed nor uniform. While patterns may be observed in the population at large, the health of individuals within any group will vary widely. And regardless of disparities, many disadvantaged groups in Alaska have seen substantial improvements across a wide range of health indicators over the last several decades.

3.4.12.5 Health Determinants

To a large extent, health is determined by where we live, the state of our environment, our income and education levels, our jobs, and our relationships with friends, family, and the larger community. These critical factors are often called health determinants (or determinants of health) because of their roles in shaping health in individuals and communities. Some health determinants are under the direct control of individuals: for example, the choice to abuse alcohol or to smoke, to eat healthy foods, or to use snowmachine or four-wheeler helmets. Other health determinants are more closely tied to the physical environment (e.g., air and water quality; subsistence resources); activities under the control of governments (public utilities, land use, access to alcohol and tobacco); working conditions (jobs, income); or the social environment (social, emotional, and religious supports).

The biomedical health outcomes described in section 3.4.12.4 share the fact that rates of disease incidence, prevalence, and mortality are driven in large part by these determinants, although other factors, such as genetic factors, also play a role. The effects of individual health determinants on disease rates often persist even after controlling for standard risk factors such as smoking rates, cholesterol and blood pressure levels, and overall poverty.

The following sections describe a number of health determinants that are relevant for the affected population and to potential development that may stem from land management of the NPR-A. These health determinants represent part of the pathway between resource development activities and biomedical health outcomes.

Table 3-54 shows where there is an evidence-based interaction between the health determinants presented below and the biomedical health outcomes presented above, especially those that may be applicable for the affected population (Driscoll 2007).

Table 3-54. Interaction between health determinants and health outcomes in the North Slope Borough

	Chronic diseases	Infectious diseases	Nutritional outcomes	Injuries	Social pathologies and mental health	Maternal and child health
Income and employment	x	x	x	x	x	x
Subsistence participation and diet	x	x	x	x	x	
Housing	x	x		x	x	x
Education				x	x	x
Health care services	x	x	x	x	x	x
Motor vehicle safety				x		
Public utilities and services		x				x
Alcohol and drug misuse	x	x		x	x	x
Smoking	x	x				x
Physical activity	x		x	x		
Culture and language			x		x	
Environmental contamination	x		x		x	x
Climate change		x	x	x		

Source: Driscoll (2007), Social and Physical Determinants of Alaskan health: A Meta-analysis

Income and Employment

The economy is one of the fundamental drivers of population health and wellness. A large body of research has explored the links to health of both societal-level economic structure (such as disparity) and individual-level wealth (such as income and job satisfaction). At its most basic, income provides the ability for individuals to meet their core needs: shelter, food, clothing, and other necessities. However, the health benefits of a "good job" go far beyond bare necessity. Work that provides an identity, social networks, a sense of worth and opportunities for personal growth can drive health outcomes, such as longevity, reductions in chronic disease, and a greater sense of well-being (Doyle et al. 2005). At the same time, workplace hazards—for example, from physical risks through chemical exposures—can be a significant source of ill health in a community.

The affected area, like most of rural Alaska, faces fluctuating employment markets with limited job opportunities and chronic levels of unemployment and underemployment.

Iñupiat residents have identified the lack of good jobs as a priority issue (Poppel et al. 2007). Importantly, residents state that they would prefer to participate in a combination of wage-based and traditional subsistence activities (Poppel et al. 2007).

Poverty has a devastating negative impact on health, particularly for children, due to its association with chronic stress, poor nutrition, increased exposure to crime and victimization, fewer opportunities and problems with access to health care. From 2001–2008, the North Slope Borough estimated rates of residents living below the poverty level were above state levels (Circumpolar Research Associates 2010) despite the oil and gas development that occurred during this time. In the Northwest Arctic Borough, the percent of residents estimated to be living below the federal poverty level was 18 percent in 2004 (Alaska Native EpiCenter 2008). Poverty may disproportionately affect the Iñupiat population, which has substantially lower median household incomes than non-Iñupiat North Slope Borough residents (Circumpolar Research Associates 2010).

Economic indicators for North Slope Borough communities are discussed extensively in section 3.4.11.

Subsistence Participation and Diet

Diets in the North Slope Borough include both traditional, or subsistence, foods, and non-traditional, or store, foods. Traditional diets are associated with numerous health benefits and reduced risk of many chronic diseases including diabetes, high blood pressure, high cholesterol, heart disease, stroke, arthritis, depression, and some cancers (Reynolds et al. 2006, Murphy et al. 1995, Adler et al. 1994, 1996, Ebbesson et al. 1999, Bjerregaard et al. 2004).

While evidence of dietary habits in the North Slope Borough is limited, subsistence sources are an important food source to North Slope Borough residents. In the 2010 North Slope Borough census, 54 percent of households indicated that they get at least half of their meals from subsistence sources. Data from the 2003 North Slope Borough census show that virtually all Iñupiat households reported relying on subsistence resources to some extent. The North Slope Borough also has among the highest per capita harvests of subsistence food in Alaska (McAninch 2010). Income opportunities do not appear to substantially affect participation in subsistence activities: in agreement with previous literature (Poppel et al. 2007), even household heads with full-time employment relied heavily on traditional food sources (McAninch 2010).

However, research and anecdotal evidence from the North Slope Borough and surrounding areas suggests a trend away from subsistence food sources, particularly in younger people (Ballew et al. 2006). Two recent studies in Alaska found greater consumption of traditional foods by elders, and more nontraditional foods by younger people (Nobmann et al. 2005, Bersamin and Luick 2007). The North Slope Borough villages are similar to many other Arctic communities in this respect: people across the circumpolar regions are increasingly replacing traditional subsistence foods, which are associated with numerous health benefits, with store-bought foods that are often high in sugar, calories, and unhealthy types of fat. North Slope Borough residents are also consuming high levels of sodas and other sugared beverages (Circumpolar Research Associates 2010).

Table 3-55. Percent subsistence participation and food insecurity in the North Slope Borough

	Anaktuvuk Pass	Atqasuk	Barrow	Kaktovik	Nuiqsut	Point Hope	Point Lay	Wainwright	All North Slope Borough
Times last year when household found it difficult to get the foods they needed to eat healthy meals	57	59	28	40	38	36	51	46	35
If yes, because not able to get enough subsistence foods	71	34	34	44	53	59	48	36	43
If yes, because not able to get enough store foods	80	100	90	88	87	86	96	95	90
Households that get at least half of their meals from subsistence sources	67	58	44	67	67	64	61	67	54

Source: Circumpolar Research Associates (2010), North Slope Borough Census.
Note: Includes all head of households (survey respondents)

A common explanation for the trend away from subsistence food sources has been residents' concern over the quality of traditional foods. Many people believe subsistence foods are contaminated (Poppel et al. 2007). The issue of contamination is complex, and the potential for harm due to ingestion of contaminants has not been definitively answered. Nonetheless, the perception of contamination (regardless of whether or not any "real" contamination exists) may lead people to avoid healthy traditional foods and rely more heavily on store-bought foods, with resulting health consequences. Other reasons that have been cited for choosing store-bought foods over traditional foods included not having anyone to hunt for the family, and lack of transportation, time, or traditional knowledge to hunt and gather (Ballew et al. 2004).

A limited availability and variety of store-bought food is particularly prevalent in rural Alaska, due to small village sizes, high costs, and limited transportation. This results in a domination of foods that have a longer shelf-life, which tend to be high in fat, salt, and calories.

Subsistence resources and use of them are discussed extensively in section 3.4.3.

Housing

Healthy housing is safe, affordable, and private. The physical condition of housing can affect health very directly; the hazards associated with lead paint, asbestos, mold, indoor air pollution, inadequate heating and unsafe cooking facilities—as just a few examples—are well known. However, the social condition of housing is equally important to health. In particular, housing insecurity and overcrowding are two very strong drivers of ill health in northern regions, affecting transmission of infectious disease, respiratory disease, mental health, stress, educational success, domestic abuse, and violence (Cave et al. 2004).

According to the 2000 U.S. Census, the North Slope Borough had an average of 3.45 persons per household and the Northwest Arctic Borough had an average of 3.87, compared with 2.59 for the U.S. and 2.74 for the State of Alaska (U.S. Census Bureau 2000), suggesting that the population in the affected environment is already subject to crowding. In addition, some houses lack basic amenities such as running water, which may contribute to poor health and the spread of disease (Wenger et al. 2010, Hennessy et al. 2008). In the Maniilaq service area, 82 percent of communities and residences has water and sewer service (Alaska Native EpiCenter 2008).

Education

Education is strongly tied to health and well-being (Ungerleider and Keating 2002). People with low levels of education are more likely to be unemployed, poor, in ill health, and to die early. Part of this link is situational; education gives people knowledge and skills for problem solving, it increases occupational prospects, and it enhances people's ability to access and understand health-related information. People with higher levels of education also tend to smoke less, to be more physically active, and to have access to healthier food, in addition to having more job opportunities and income. Education may also mitigate some negative influences such as poverty and discrimination. Education has been linked to biological outcomes associated with disease, such as changes in inflammatory markers that are risk factors for coronary heart disease (Loucks et al. 2006).

Literacy is a particularly strong predictor of health and wellness (Ronson and Rootman 2004). It has been directly linked to overall health status, mental health status, life expectancy, and certain diseases. Low literacy raises the potential for increased harm through misreading of product information on medications, instructions for handling dangerous products or processes, or other written material in the workplace and at home. However, the effect of literacy on health and wellness in the affected environment for this EIS is not known.

The North Slope Borough has invested heavily in education; it spends more than twice the state average per-student on education (Alaska Department of Education and Early Development 2009) and has made an effort to incorporate Iñupiat values, culture, and language into the school curriculum. These efforts have found moderate success. Education levels in the North Slope Borough have been increasing since 1980 and are higher than in some comparison remote rural communities. However, the school dropout rate has also increased during this time, and school graduation rates and educational attainment levels remain below statewide averages. Within the Maniilaq service area, 66 percent of the population ages 25 or older had attained a high school diploma or GED as of 2000 (Alaska Native EpiCenter 2008). Within the North Slope Borough, the current high school graduation rate (for the 2008–2009 school year) ranges from 50 to 100 percent of students, with variation by community.

Controversy continues to exist between the issues of meeting statewide education requirements while integrating Native language and culturally relevant curriculum. These initiatives take place in the context of a painful chapter in the history of education in Alaska, in which children attended boarding schools run by the Bureau of Indian Affairs, in which traditional language and cultural practices were disallowed (Hirschberg and Sharp 2005).

Health Care Services

Health care resources play a specific role in prevention—and a widespread role in treatment—of disease and illness. The adequacy of health care resources is dependent on both universality of access and availability of resources. The provision of health care services may be limited, especially in rural areas, by the unavailability of health care providers. Rural areas often have problems with both recruitment and retention of medical personnel, and some areas are chronically understaffed and underserved. Access to specialist care (and some of the allied health professions, such as mental or nutritional health) is also quite limited in rural areas, unless the patient travels to a major population center.

Provision of health care in the North Slope Borough is the joint responsibility of the North Slope Borough and the Arctic Slope Native Association. Other than Barrow, all North Slope Borough villages of the North Slope Borough maintain a clinic that is staffed by community health aide/practitioners. None of these villages have a physician or physician's assistant in residence. Barrow houses the Samuel Simmonds Memorial Hospital, a 14-bed hospital with an outpatient unit that consists of a 6-room clinic and a 2-bed emergency room (Arctic Slope Native Association 2010). Barrow acts as the tertiary care center for the North Slope Borough villages, with cases referred to Fairbanks or Anchorage if they cannot be taken in Barrow. Barrow also has a Community Mental Health Center, a public health department, and a dental clinic.

Health services in and near the Northwest Arctic Borough are provided through the Maniilaq Association, which is responsible for the provision of extensive health, tribal, and social services to residents of rural Northwest Alaska. The communities served by the Maniilaq Association include Ambler, Kiana, Kobuk, Kotzebue, Noatak, Noorvik, Selawik, Shungnak, and Point Hope as well as Deering, Kivalina, and Buckland. Kotzebue houses the Maniilaq Health Center, a primary health care facility that offers an emergency room, an ambulatory care clinic, dental and eye care clinics, a pharmacy, a specialty clinic, and an inpatient wing with 24 beds. In Maniilaq-served communities outside of Kotzebue, the Community Health Aide/Practitioner Program operates remote village clinics staffed by two to four health aides, supported by electronic access to the Maniilaq Health Center in Kotzebue. Several times a year specialized doctors, dentists, and eye doctors make regularly scheduled visits to these clinics to provide specialized care not usually offered in the area (Maniilaq Association 2010).

Alaska Native Health Service provides health insurance to all Alaska Natives and over 97 percent of adult North Slope Borough residents have health insurance compared to 83 percent of adults statewide (Table 3-56 and Table 3-57). While insurance coverage is very good, access to services is severely inhibited by the remote location of the villages and severity of the climate. The costs and inconvenience of travel necessary for many services is cited as a barrier (McAninch 2010). Another barrier is the fragmentation of services and complications resulting from the coordination of multiple parties in different locations to provide care. Finally, most of the communities suffer from chronic health care workforce shortages and turnover, to the extent that the U.S. Health Resources and Services Administration characterizes the North Slope Borough and the Northwest Arctic Borough as medically underserved and health professional shortage areas.

The Alaska Native Tribal Health Consortium has supported the development of telehealth technologies to support health-related communications in Alaska, through the Alaska Federal Health Care Access Network.

Table 3-56. Health insurance in the North Slope Borough

	All North Slope Borough	All Alaska
Have health insurance, including Indian Health Service eligibility	97%	82%[a]
Have health insurance, other than Indian Health Service eligibility	64%	--

Source: Circumpolar Research Associates (2010), North Slope Borough Census with the exception of:
a Centers for Disease Control and Prevention (2009), Behavioral Risk Factor Surveillance System.
Note: Includes all head of households (survey respondents).

Table 3-57. Health insurance across Alaska

Indicator	All Alaska	American Indian/Alaska Native	All rural Alaska
Proportion of Alaskan adults with health care coverage	83.2% (95% confidence interval: 81.4% - 84.8%)	84.3% (95% confidence interval: 80.9% - 87.2%)	78.9% (95% confidence interval: 75.4% - 82.0%)

Source: Parnell et al. (2008), Health Risks in Alaska Among Adults: Alaska Behavioral Risk Factor Survey 2008.

Motor Vehicle Safety

The largest single cause of unintentional injury deaths in the North Slope Borough is motor vehicle accidents. Between 1999 and 2008, the North Slope Borough experienced a motor vehicle (including snowmachines, all-terrain vehicles, and other off-road vehicles) injury death rate of 45.6 deaths per 100,000 population compared with a rate of 16.3 for all of Alaska. Motor vehicle injuries also resulted in high rates of hospitalizations and traumatic brain injuries.

Seatbelts have been shown to reduce injury and death from motor vehicle accidents, yet a majority (63 percent) of North Slope Borough high school students and roughly one-third of adults reported never or rarely wearing a seatbelt while a passenger. Rates of helmet use in Alaska are significantly lower for citizens in rural areas, and in the North Slope Borough, only 18 percent of census respondents reported using helmets when riding a snowmachine or four-wheeler.

The 2008 "Health Risks in Alaska Among Adults" report provides seatbelt usage rates for rural Alaska as well as Alaska Native adults. Seatbelt usage was similar for Alaska Natives and rural Alaskans (86.2 percent and 84.7 percent respectively) and for non-Native Alaskans and metropolitan areas of Alaska (93.8 percent and 95.3 percent, respectively) (Parnell et al. 2008).

Public Utilities and Services

Public utilities play an important role in community health and wellness. Safe drinking water and appropriate disposal of waste prevent the spread of many serious transmissible diseases. Electricity and heating are also important to health and wellness; studies have linked insufficient heating with poor health outcomes, particularly in children and older people. The type of heating source also plays a role, as different heating modes (gas, wood stove, electricity, etc.) create different levels of indoor air pollutants such as carbon monoxide or particulate matter. Other aspects of public infrastructure and services, including fire control, rescue services, and emergency preparedness are critical when an unexpected situation arises. The ramifications of not maintaining adequate infrastructure can include severe public health and safety consequences such as road trauma, death or injury from fire or violence, and transmission of water-borne illness or other infectious disease. In an extreme health emergency, the existence or lack of adequate planning may make an enormous difference in disease transmission and death in the community (Centers for Disease Control and Prevention 2010).

The North Slope Borough maintains a centralized headquarters to coordinate the provision of fire, rescue, and emergency medical services and oversees nine fire rescue stations, all of which house, at a minimum, an ambulance, engine, and tanker to provide emergency medical services response and fire protection to the community (North Slope Borough Fire Department 2010). Following considerable investment by the Borough, an estimated 94 percent of North Slope Borough households have modern water and sewer service as of 2008, compared with an average of 76 percent for Tribal Health Regions statewide (Alaska Native EpiCenter 2009, Circumpolar Research Associates 2010, McAninch 2010). The "Healthy Alaskans 2010" target is for 98 percent of households across the state to have modern water and sewer service. The cost and complexity of maintaining and repairing expensive water and sewer systems in the North Slope Borough are ongoing concerns.

The Northwest Arctic Borough maintains a number of public services designed to protect public safety, including a fire department and fire prevention programs for all communities, a search and rescue department, an emergency management department, a public safety program, and shelter cabins. The Borough has drafted a 5-year safety plan that will strengthen public services in all communities, and is in the process of revising their Emergency Preparedness Plan (Northwest Arctic Borough 2010).

Alcohol and Drug Misuse

Alcohol abuse is linked to chronic disease, interpersonal violence, injuries, disintegration of family structure and well-being, and adverse home environments for children. Within the North Slope Borough, alcohol is involved in an estimated 40 percent of snowmachine-related injury hospitalizations, 70 percent of assault injuries, 57 percent of suicide attempts, and 45 percent of motor vehicle-related injury hospitalizations. Many incidents of interpersonal violence or injury in particular are associated with "binge," or episodic, heavy drinking.

In the North Slope Borough, the sale and importation of alcohol is prohibited in all villages but Barrow, which prohibits the sale but not the importation of alcohol. Restrictive alcohol policies in rural Alaskan villages are associated with decreased incidence of alcohol-related injuries and other health problems (Chiu et al. 1997, Landon et al. 1997), and the North Slope Borough's laws appear to be moderately effective: binge drinking and prenatal drinking in the North Slope Borough seem to have decreased since the 1990s. Currently, there does not appear to be a significant difference in self-reported periodic heavy, or "binge," alcohol consumption compared to the state of Alaska or the nation. In 2005–2007 the rate of binge drinking among adults in the North Slope Borough was estimated at 17 percent (McAninch 2010), similar to the rates shown in Table 3-58. In 2005, the rate of self-reported consumption of any alcohol among North Slope Borough high school students was significantly lower than the national average, and self-reported binge drinking among North Slope Borough high school students was not significantly different from state or national estimates. In the Northwest Arctic Borough, a 2010 vote allowed the selling of liquor in the community of Kotzebue via a city-run package store and distribution center.

In the Maniilaq service area, self-reported rates of binge drinking among Alaska Natives decreased between 1996 and 2004, from 21 percent of adults to 14 percent, with rates that are lower than seen for all Alaska Natives (Alaska Native EpiCenter 2008).

Table 3-58. Alcohol misuse across Alaska

Indicator	All Alaska	American Indian/Alaska Native	All Rural Alaska
Binge drinking: Proportion of males having 5 or more drinks or females having 4 or more drinks on at least one occasion in the past 30 days.	15.1% (95% confidence interval: 13.6% - 16.7%)	18.3% (95% confidence interval: 14.8% - 22.4%)	14.4% (95% confidence interval: 12.1% - 17.0%)
Excessive drinking: Proportion of males having more than 2 drinks per day or females having more than 1 drink per day in the past 30 days.	6.2% (95% confidence interval: 5.1% - 7.5%)	5.8% (95% confidence interval: 3.5% - 9.2%)	5.1% (95% confidence interval: 3.6% - 7.2%)

Source: Centers for Disease Control and Prevention (2008), Behavioral Risk Factor Surveillance System

Smoking

Rates of tobacco use in the North Slope Borough are very high compared to most other areas of Alaska, with almost half of adults engaged in regular smoking (Table 3-59). Although the North Slope Borough census found a smoking rate of only 3 percent among children under 18, this data was gathered by asking the head of household about the child's smoking status and may under-represent the true number. A 2004 survey that interviewed North Slope Borough students found that roughly one-quarter of seventh and eighth graders and two-thirds of high school seniors reported smoking cigarettes in the previous 30 days (Alaska Department of Education and Early Development 2005). Within the Maniilaq service area, 77 percent of patients who were asked about their tobacco use reported that they were current tobacco users. No users of the Maniilaq service area had received tobacco cessation intervention within the past year (Alaska Native EpiCenter 2008).

Table 3-59. Tobacco use in the North Slope Borough

Percent who smoke tobacco (in any form)	All North Slope Borough	All Alaska
Adults	49%	21%[a]
Children under 18	3%	--
Percent of household heads who permit smoking in the house	33%	--

Source: Circumpolar Research Associates (2010), North Slope Borough Census with the exception of:
a Centers for Disease Control and Prevention (2009), Behavioral Risk Factor Surveillance System.

Smokers face increased risks for several diseases and ailments. Smoking tobacco increases risks of developing a large number of ailments, including lung and other types of cancer, chronic lower respiratory disease, coronary heart disease, stroke, sexual dysfunction, and periodontal disease among others (McAninch 2010, Indian Health Service 1999).

Physical Activity

Regular physical activity provides numerous benefits to mental and physical health: it decreases risks for many diseases, including diabetes, depression, high blood pressure, and heart disease; it can improve mood and concentration; and it can decrease risks for some types of chronic pain. Participation in physical activity is influenced by a number of factors, including social norms, educational and income level, occupation, leisure time, health problems, and opportunities or barriers present in the physical environment.

The percentage of adults in the North Slope Borough who meet the Centers for Disease Control and Prevention's recommended physical activity levels for moderate physical activity (30 minutes or more of moderate physical activity at least 5 days per week) appears to be about on par for the state of Alaska (44 percent vs. 47 percent; Table 3-60). However, a somewhat greater percentage of North Slope Borough residents than other Alaska residents report never exercising at a level that would confer health benefits (16 percent vs. 9 percent).

In the Maniilaq service area, the percentage of adults in 2004–2005 who met the recommended physical activity levels was similar, at 46 percent (Alaska Native EpiCenter 2008).

Table 3-60. Exercise habits in the North Slope Borough

	All North Slope Borough	All Alaska
Never get 30 minutes of moderate exercise in a day	16%	9%[a]
Get at least 30 minutes of moderate exercise 5 days per week or more	44%	47%[a]

Source: Circumpolar Research Associates (2010), North Slope Borough Census with the exception of:
a Centers for Disease Control and Prevention (2007), Behavioral Risk Factor Surveillance System.
Note: Respondents limited to household heads.

Culture and Language

Culture and ethnicity are important determinants of health, as they influence almost all aspects of how we live. Culture and language provide the framework in which we understand and interpret our surroundings, and provide a set of "ready-made" choices about lifestyle and behavior (e.g., eating and physical activity patterns, use of tobacco, risk-taking behavior, interaction with health care alternatives, etc.).

The North Slope Borough has made several efforts towards strengthening culture and language among the Iñupiat peoples. The school curriculum in the North Slope Borough now includes Alaska Native culture, history, and language (Circumpolar Research

Associates 2010), and language ability among North Slope Borough Iñupiat compares very well to neighboring regions of Bering Straits and the Northwest Arctic Borough.

However, there are several threats to culture and language in the North Slope Borough. Younger residents do not have the fluency of older residents with Iñupiat language (Circumpolar Research Associates 2010, Poppel et al. 2007). Subsistence foods—believed by many Iñupiat and other Alaska Natives to be the very foundation of health and well-being—are increasingly viewed as threatened in terms of both availability and potential contamination, and this may impact participation in subsistence activities and food sharing social networks (McAninch 2010).

Subsistence resources are discussed in depth in section 3.4.3.

Environmental Contamination

Residents of the North Slope Borough are quite concerned about environmental contamination, particularly as it relates to contamination of subsistence food sources. In a recent survey, 44 percent of Iñupiat village residents reported concern that fish and animals may be unsafe to eat (Poppel et al. 2007).

Environmental contaminants have the potential to affect human health in a number of ways. First, exposure to contaminants via inhalation, ingestion, or absorption may induce adverse health effects depending on a number of factors, including the nature of the contaminant, the amount of exposure, and the sensitivity of the person who comes in contact.

Aside from actual exposure to environmental contamination, the perception of exposure to contamination is also linked with known health consequences. Perception of contamination may result in stress and anxiety about the safety of subsistence foods and avoidance of subsistence food sources (Canadian Environmental Assessment Agency 2010, Joyce 2010, Loring et al. 2010), with potential changes in nutrition-related diseases as a result. It is important to note that these health results arise regardless of whether or not there is any "real" contamination at a level that could induce toxicologic effects in humans; the effects are linked to the perception of contamination, rather than to measured levels.

The issue of exposure to environmental contaminants is contentious, and few data exist to support or deny resident concerns regarding degradation of environmental quality and local health impacts. In general, the field of public health addresses this concern through efforts to control exposure to environmental contaminants, rather than through responding to specific increases in disease rates related to a known exposure. Other sections of this chapter, including those related to air quality (section 3.2.2), water resources (section 3.2.10) and solid and hazardous wastes (section 3.2.11) discuss some of the media through which humans could be exposed to contamination.

3.4.12.6 Public Health and Climate Change

Rural Arctic communities are particularly vulnerable to the health effects of climate change, and global warming is increasingly becoming recognized as a determinant of health in the Arctic (Arctic Council and International Arctic Science Committee 2005). Changing weather and ice patterns have the potential to affect a wide range of health-related outcomes. Climate change may affect both subsistence food availability and storage and may increase risks associated with subsistence activities, which in turn may lead to dietary and cultural change. Climate change can also affect water, sanitation, housing, transportation infrastructure, cultural continuity, community stress levels, the spread of infection, and even the types of diseases and infections to which the population is susceptible (Arctic Climate Impact Assessment 2004, Brubaker et al. 2010, Brubaker et al. 2011).

Research has postulated that climate change may in the future alter human exposure to contaminant levels, through changes in atmospheric or oceanic transport patterns as well as via precipitation, animal availability and accessibility, UV radiation, cryosphere degradation and climate-related enabling of human industrial activities (Kraemer et al. 2005). Research has also postulated changes in infectious disease related to changes in temperature-sensitive foodborne diseases such as gastroenteritis; increases in zoonotic and vector-borne diseases such as West Nile virus, waterborne infections such as giardia (Parkinson and Butler 2005), or illness spread from damage to sanitation infrastructure (Warren et al. 2005). Linked to this is the observed melting of the ice cellars (Barber 2010), which may bring in questions about food safety. In addition, it has been postulated that climate change may increase the potential for wildfires, which could exacerbate respiratory problems in people exposed to smoke in the NPR-A.

Two reports prepared on climate change and health effects in northwest Alaska—specifically in Point Hope and Kivalina—indicate a number of negative health effects that are attributed by local residents to climate-related changes. These include: exposure to smoke, dust, and pollen; ice changes that increase the risk of injury; injuries, chest pain, stress and anxiety related to preparation for extreme weather events; changes in drinking water quality; difficulty in travelling over some terrain and rivers to reach traditional food sources; changing ranges of plants and wildlife; decline in some food species; and potential threat from polar bears.

Villages in the North Slope Borough are already experiencing some effects of climate change: erosion problems, less reliable ice conditions, and higher risk to hunters and spring whalers. Several villages south of the Brooks Range that rely to some extent on the Western Arctic Caribou Herd (Kivalina, Shishmaref and Newtok) are actively planning to relocate due to climate-induced erosion problems. Climate change will likely result in rapidly changing physical environment and health conditions for this population in the coming years.

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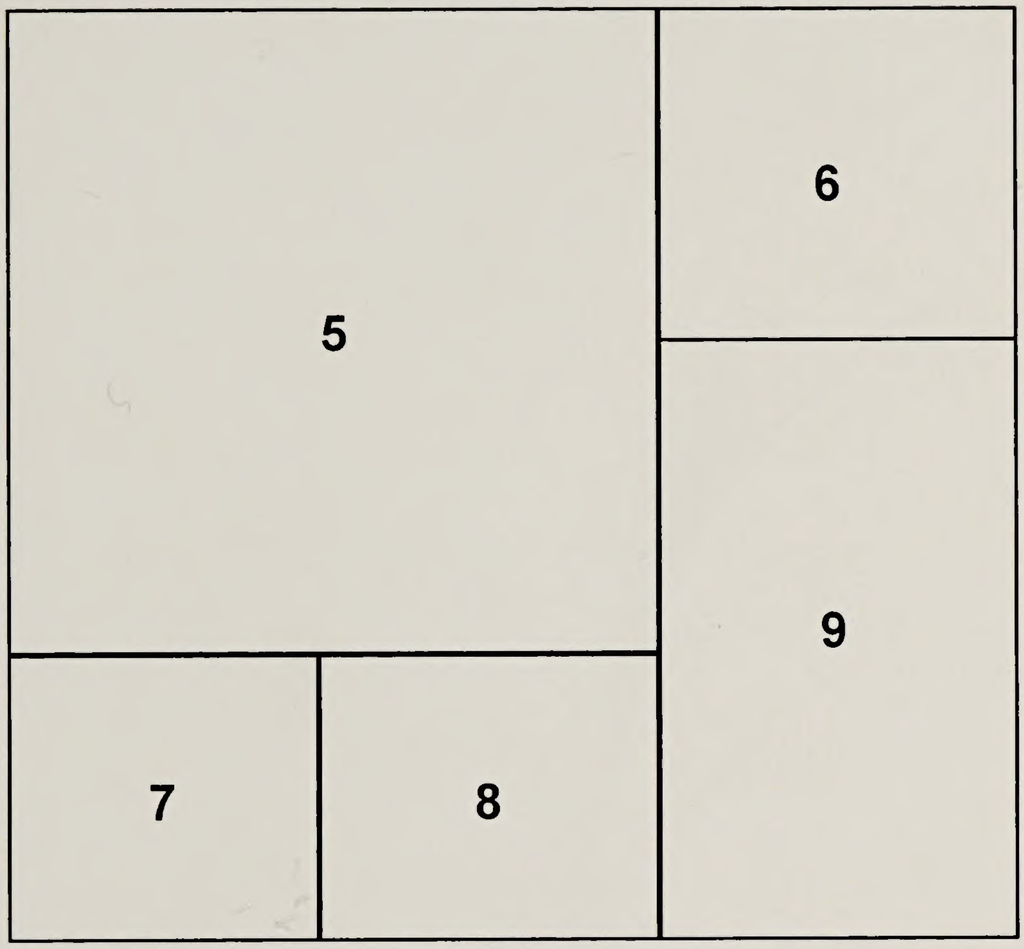

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5. Coastal erosion due to warming permafrost shoreline, National Petroleum Reserve-Alaska.
   Photo by University of Texas.

6. Arctic Fox, National Petroleum Reserve-Alaska.

7. Transporting exploration drill rig equipment, National Petroleum Reserve-Alaska.
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8. Bear flowers on a thermokarst slump along the Colville River, National Petroleum Reserve-Alaska.
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